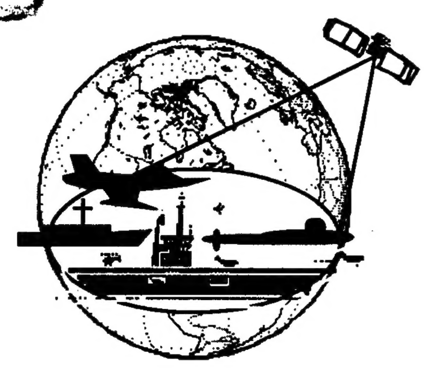
NAVY COOPERATIVE ENGAGEMENT ARCHITECTURE

VOLUME TWO
WORKING GROUP FINAL REPORT

APPENDICES A THRU E

WSA&E
WARFARE SYSTEMS ARCHITECTURE & ENGINEERING
SPAWAR 30



JUNE 1991

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

APPENDIX A

ABBREVIATIONS AND ACRONYMS

TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

ABBREVIATIONS

A

ACAT	Acquisition Category
ACK	Acknowledge
ACK/NAK	Acknowledge/Not Acknowledged
AD	Destroyer Tender
ADV	Advanced
AE	Ammunition Ship
AFS	Combat Stores
AFSATCOM	Air Force Satellite Communications
AFSOUTH	Allied Forces Southern Europe
AG	Aegis
AGDS	Auxiliary Deep Submergence Support
AGF	Amphibious Command Ship
AGSS	Auxiliary Submarine (Diesel)
ALT	Alteration
AO	Oiler
AOE	Fast Combat Support Ship
AOR	Replenishment Oiler
AR	Repair Ship
ARS	Salvage Ship
AS	Submarine Tender
ASAT	Antisatellite
ASR	Submarine Rescue
ASROC	Antisubmarine Rocket
ASTAB	Automatic Status Board
ATEAMS	Advanced Capability Tactical EA-6B Mission Support System
ATF	Fleet Ocean Tug
ATS	Salvage and Rescue Ship
AUTH	Authorized
AUTO	Automatic
AUTODIN	Automatic Digital Information Network
AUTOSEVOCOM	Automatic Secure Voice Communications
AUTOVON	Automatic Voice Network
AVM	Guided Missile Ship
AVT	Auxiliary Aircraft Landing Trainer

B

BARCAP	Barrier Combat Air Patrol
BB	Battleship
BCAST	Broadcast
BK	Black
BLK	Block
BRDCST	Broadcast
BT	Bathythermograph

C

CANDY	Surface Gun Ordnance Status
CANTCO	Cannot Comply
CAPEXP	Capability Expansion
CASCOR	Casualty Correction Report
CASREP	Casualty Report
CEN	Center
CG	Cruiser, Guided Missile
CGN	Cruiser, Guided Missile (Nuclear)
CH	Channel
CHAFFROC	Chaff Dispensing Rocket
CINC	Commander in Chief
CINCLANT	Commander in Chief, Atlantic
CINCLANTFLT	Commander in Chief, Atlantic Fleet
CINCPAC	Commander in Chief, Pacific
CINCPACFLT	Commander in Chief, Pacific Fleet
CINCUSNAVEUR	Commander in Chief, US Navy Forces Europe
CMD	Command
CMPTNG	Computing
CNSTR	Canister
CNTL	Control
COMCARGRU	Commander, Carrier Group
COMDESRON	Commander, Destroyer Squadron
COMEX	Commence Exercise
COMINT	Communications Intelligence
COMM	Communications
COMNAVSECGRU	Commander, Naval Security Group
COMNAVSPACECOM	Commander, Naval Space Command
COMNAVSURFLANT	Commander, Naval Surface Force Atlantic Fleet
COMNAVSURFPAC	Commander, Naval Surface Force Pacific Fleet
COMNAVTELCOM	Commander of Naval Telecommunications
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
COMSEC	Communications Security
COMSECONDFLT	Commander, Second Fleet
COMSEVENTHFLT	Commander, Seventh Fleet
COMSIXTHFLT	Commander, Sixth Fleet
COMSPAWARSYSCOM	Commander, Space and Naval Warfare Systems Command
COMSUBGRU	Commander, Submarine Group
COMUSJAPAN	Commander, US Forces Japan
COMUSKOREA	Commander, US Forces Korea
CONTD	Continued
CONV	Conventional
CORR	Correlation
CTR	Center
CV	Aircraft Carrier

CVN	Aircraft Carrier (Nuclear)

D

DD	Destroyer
DDG	Destroyer, Guided Missile
DESIG	Designate
DEV	Development
DIG	Digital
DIR	Director
DTD	Dated

E

EASTPAC	Eastern Pacific
ECON	Economical
ELINT	Electronic Intelligence
EMCON	Emission Control
EMPSKED	Employment Schedule
ENC	Enclosure
ENG	Engage
EQUIP	Equipment
EX	Experimental
EXAREA	Exercise Area
EXP	Expansion
EXPNDBL	Expendable

F

FANFARE	Shipboard Torpedo Countermeasures Systems
FATHO	Fathometer
FF	Frigate
FFG	Frigate, Guided Missile
FINEX	Finish Exercise
FLTBCST	Fleet Broadcast
FLTBDCST	Fleet Broadcast
FLTCINC	Fleet Commander in Chief
FLTDECGRU	Fleet Deception Group
FLTSAT	Fleet Satellite
FLTSATCOM	Fleet Satellite Communications
FNDR	Finder (Channel)
FORSCOM	Forces Command

G

GAPSAT	Gapfiller Satellite
GENSER	General Service
GEOPOSITION	Geographic Position
GRP	Group

GUID	Guidance

H

HAVEQUICK	Voice Link Upgrade
HELO	Helicopter
HICOM	High Command Communications Circuit
HIFRAG	High Fragmentation
HPN	Harpoon
HQ	Headquarters

I

ID	Identification
ILOG	Incoming Log
IMINT	Imagery Intelligence
IMP	Improved
INCR	Increment
INMARSAT	International Maritime Satellite Organization
INST	Installed
INTEG	Integrate
INTEL	Intelligence
IONOSPSNDR	Ionospheric (CHIRP) Sounder
IR	Infrared

J

JINTACCS	Joint Interoperability of Tactical Command and Control System

K

KTS	Knots

L

LANT	Atlantic
LAT	Latitude
LCC	Amphibious Command Ship
LCHR	Launcher
LEASAT	Leased Satellite
LHA	Amphibious Assault Ship, General Purpose
LHD	Amphibious Assault Ship, Dock
LKA	Amphibious Cargo Ship
LONG	Longitude
LORAN	Long Range Navigation
LPD	Amphibious Transport, Dock
LPH	Amphibious Transport, Helicopter
LSD	Landing Ship, Dock

LST	Landing Ship, Tank
LTLD	Light Load
LTR	Letter

M

MAG	Magnetic
MARISAT	Maritime Satellite
MAX	Maximum
MDL	Model
MECH	Mechanical
MERCO	Merchant Ship Movement and Control
MIGCAP	Combat Air Patrol-Defense of Strike Missions
MILSATCOM	Military Satellite Communications
MILSTAR	Military Srategic and Tactical Relay Satellite System
MIN	Minimum
MISC	Miscellaneous
MK	Mark
MOB	Mobility
MOD	Modification
MOVREP	Movement Report
MSG	Message
MSH	Minesweeper, Hunter
MSL	Missile
MSO	Minesweeper, Ocean

N

NAK	Not Acknowledged
NAV	Navigation
NAVAIR	Naval Air Systems Command
NAVCOMSTA	Naval Communications Station
NAVCOMPARS	Naval Communications Processing and Routing System
NAVCOMPT	Navy Comptroller
NAVDEV	Navigation Devices
NAVFAC	Naval Facility
NAVFORSTAT	Naval Force Status
NAVINTCOM	Naval Intelligence Command
NAVMACS	Naval Modular Automatic Communication System
NAVOPINTCEN	Naval Operational Intelligence Center
NAVSAT	Navigation Satellite
NAVSEA	Naval Sea Systems Command
NAVSEASYSCOM	Naval Sea Systems Command
NAVSPACECOM	Naval Space Command
NEUT	Neutralization
NIXIE	Surface Ship Acoustic Torpedo Countermeasures System

NM	Nautical Miles
NO	Number
NOFORN	Not Releaseable to Foreign Nationals
NOTAC	No Attack
NUC	Nuclear

O

OLOG	Outgoing Log
OMEGA	Radio Navigation Equipment
OPCON	Operational Control
OPCONC	Operations Control Center
OPDEC	Operational Deception
OPEVAL	Operational Evaluation
OPGEN	Operational Generation
OPINTEL	Operational Intelligence
OPNAV	Office of the Chief of Naval Operations
OPNOTE	Operational Note
OPORD	Operation Order
OPPLAN	Operational Plan
OPSCOMMS	Operations Communications
OPSEC	Operational Security
OPSPEC	Operational Specification
OPTASK	Operational Task
OPTEVFOR	Operational Test and Evaluation Force
ORDALT	Ordnance Alteration

P

PAC	Pacific
PACQ	Probability of Acquisition
PALRT	Probe Alert
PAPA	COMM Multichannel Transmitand Receive Capability
PHM	Patrol Hydrofoil
PHOTOINT	Photographic Intelligence
POS/NAV	Position and Navigation
PREC	Precise
PROC	Processor
PROFILE	Passive Radio Frequency Interference Location Experimental Satellite
PROG	Program

Q

R

RADHAZ	Radiation Hazzards
RCV	Receive
RCVR	Receiver
RDR	Radar
REC	Receive
RELNAV	Relative Navigation
RESCAP	Tactical Aircraft Used for Search and Rescue
REPEAT	Repeatable Performance Evaluator and Test System
RGM	Ship Surface Attack Guided Missile
RIM	Surface Ship Launched Aerial Intercept Guided Missile
RORSAT	Radar Ocean Reconnaissance Satellite
RTT	Radio Teletype
RX	Receive

S

SACINTNET	SAC Intelligence Network
SATCOM	Satellite Communications
SATNAV	Satellite Navigation
SCEN	Scenario
SEAGNAT	Chaff Decoy Round
SECNAV	Secretary of the Navy
SECVOX	Secure Voice (Communications)
SEN	Sensing
SER	Serial
SHIPALT	Ship Alteration
SHOBOM	Shore Bombardment
SIGINT	Signals Intelligence
SIGSEC	Signal Security
SITREP	Situation Report
SITSUM	Situation Summary
SLCSAT	Submarine Laser Communications Satellite
SNDR	Sounder
SNR	Sonar
SOSUS	Sound Surveillance System
SOWRBALL	Southwest Radar Ballon
SPAWAR	Space and Naval Warfare Systems Command
SPEC	Specification
SPINSAT	Special Purpose Inexpensive Satellite
SPINTCOM	Special Intelligence Communications
SPT	Support
SS	Submarine (Diesel)
SSBN	Fleet Ballistic Missile Submarine (Nuclear)
SSN	Submarine (Nuclear)
STREAMLINER	Special Intelligence Message Traffic

SUBLANT	Submarine Forces, Atlantic
SUBNOT	Submarine Notice
SUBOPAUTH	Submarine Operational Authority
SUBPAC	Submarine Forces, Pacific
SUGAR	Surface AAW Missile Ordnance Status
SUPPLOT	Supplementary Plotting Space
SURCAP	Combat Air Patrol Used for Antisurface Warfare
SURVSAT	Survivable Satellite
S/W	Software
SW	Switch
SYS	System
SYSCOM	Systems Command

T

TA	Tartar
T-AGOS	Ocean Surveillance Ship
TACAIR	Tactical Air Navigation
TACELINT	Tactical Electronic Intelligence
TACINTEL	Tactical Intelligence
TACMEMO	Tactical Memorandum
TACNAV	Tactical Navigation
TACNOTE	Tactical Note
TACON	Tactical Control
TACREP	Tactical Report
TACSAT	Tactical Satellite
TACTAS	Tactical Towed Array System
TARCAP	Combat Air Patrol Assigned Over a Target Area
TE	Terrier
TEAMS	Tactical EA-6B Mission Support System
TECH	Technical
TECHEVAL	Technical Evaluation
TECHREP	Technical Representative
TENCAP	Tactical Exploitation of National Capabilities
TGT	Target
TOMCAT	Returning Strike Sanitation Unit
TORCH	Infrared Decoy Round
TORP	Torpedo
TRANSCVR	Transceiver
TRANSEC	Transmission Security
TRAP	TRE and Related Applications
TRIPOD	Tactical Reconstruction Information Pod
TRI-TAC	Tri-Services Tactical Communications
TRK	Track
TRML	Terminal
TTY	Teletype
TX	Transmit

U

UN	Unprogrammed
UNITRACK	Unit Tracking
UNITREP	Unit Status Report
UNREP	Underway Replenishment
USSPACECOM	United States Space Command

V

VERTREP	Vertical Replenishment
VOCODER	Voice Coder

W

W	With
WESTPAC	Western Pacific
W'FARE	Warfare
WILCO	Will Comply
WNINTEL	Warning Notice-Intelligence Sources and Methods Involved
W/O	Without
WPN	Weapon
WX	Weather

X

XBT	Expendable Bathythermograph
XCVR	Transceiver
XMIT	Transmit
XMTR	Transmitter
XRIM	Experimental Surface Ship Launched Aerial ntercept Guided Missile

Y

Z

ACRONYMS

A

Ai	Inherent Availability
Ao	Operational Availability
A3ES	Advanced Antiair Warfare Engagement System
AAAM	Advanced Air-to-Air Missile
AAM	Air-to-Air Missile
AATC/DAIR	Amphibious Air Traffic Control/Direct Altidude and Identity Readout
AAW	Antiair Warfare
AAWC	Antiair Warfare Commander
AB	Alfa Bravo (OTC)
ABCCC	Airborne Battlefield Command and Control Center
ABLS	Armored Box Launching System
ABM	Antiballistic Missile
ACA	uto Correlator
ACDS	Advanced Combat Direction System
ACLS	Aircraft Carrier Landing System
ACM	Advanced Cruise Missile
ACP	Allied Communications Procedures
ACS	Aegis Combat System
ACS	Afloat Correlation System
ACTS	Aegis Combat Training System
ACU	Air Control Unit
ADA	Air Defense Artillery
ADC	Air Data Computer
ADER	Automatic Data Extraction and Recording
ADI	Air Defense Initiative
ADM	Advanced Development Model
ADP	Automated Data Processing
ADPE	Automated Data Processing Equipment
ADS	Aegis Display System
ADT	Automated Detection and Tracking
ADX	Automated Data Extraction
AE	Alfa Echo (EWC)
AFP	Approved Full Production
AEB	Active Electronic Buoy
AECM	Airborne Electronic Countermeasures
AER	Aegis Extended Range
AEW	Airborne Early Warning
AFDS	Amphibious Flag Data System AIMS
	A Air Traffic Control Radar Beacon
	I Identification Friend or Foe
	M Mk 12 Crypto Secure Identification
	S System

AJ	Antijam
ALCM	Air Launched Cruise Missile
ALP	Approved Limited Production
ALWT	Advanced Lightweight Torpedo
AM	Amplitude Modulation
AMCC	Ashore Mobile Contingency Communications
AMRAAM	Advanced Medium Range Air-to-Air Missile
AMSS	Advanced Mine Hunting Sonar System
AMSS	Advanced Multisensor System
AMW	Amphibious Warfare
ANDVT	Advanced Narrowband Digital Voice Terminal
AOA	Amphibious Objective Area
AOI	Area of Interest
AOR	Area of Responsibility
AOU	Area of Uncertainty
AP	Alfa Papa (STWC)
APPS	Acoustic Performance Prediction System
APS	Afloat Planning System
AR	Alfa Romeo (Air Resources Element Coordinator)
AREC	Air Resources Element Coordinator (Alfa Romeo)
ARM	Antiradiation Missile
ARPS	Advanced Radar Processing System
ARQ	Automatic Repeat Request
ARTIS	Advanced Radar Target Identification System
AS	Alfa Sierra (ASUWC)
ASAC	Antisubmarine Warfare Air Controller
ASAM	Advanced Surface-to-Air Missile
ASC	Automatic Switching Center
ASCII	American Standard Code for Information Interchange
ASCM	Antisurface Cruise Missile
ASIS	Amphibious Support Information System
ASLCM	Advanced Sea Launched Cruise Missile
ASM	Antiship Missile
ASMD	Antiship Missile Defense
ASU	Approval for Service Use
ASUW	Antisurface Warfare
ASUWC	Antisurface Warfare Commander
ASW	Antisubmarine Warfare
ASWC	Antisubmarine Warfare Commander
ASWCS	Antisubmarine Warfare Combat System
ASWCS	Antisubmarine Warfare Control System
ASWIXS	Antisubmarine Warfare Information Exchange System
ASWM	Antisubmarine Warfare Module
ASWOC	Antisubmarine Warfare Operations Center
ATA	Advanced Tactical Aircraft
ATACC	Advanced Tactical Air Command Center
ATARS	Advanced Tactical Reconnaissance System
ATC	Air Traffic Control
ATCC	Ashore Tactical Command Center

ATD	Automatic Target Detection
ATDS	Airborne Tactical Data System
ATES	Aegis Tactical Executive System
ATF	Amphibious Task Force
ATIDS	Automatic Tactical Information Display System
ATSA	Advanced Tactical Surveillance Aircraft
AUR	All-Up Round
AUS	ASWOC C3 Upgrade System
AW	Alfa Wiskey (AAWC)
AWACS	Airborne Warning and Control System
AWRL	After Weapon Release Line
AWS	Aegis Weapon System
AX	Alfa X-Ray (ASWC)

B

BADG	Battle Group Aegis Display Group
BAPTA	Bearing and Power Transfer Assembly
BBBG	Battleship Battle Group
BCA	Broadcast Control Authority
BCD	Binary Coded Decimal
BCS	Broadcast Control Station
BDA	Battle Damage Assessment
BE	Bullseye (HFDF System)
BF	Battle Force
BFC2	Battle Force Command and Control
BFIM	Battle Force Information Management
BFSE	Battle Force Systems Engineering
BFSEP	Battle Force Systems Engineering Plan
BG	Battle Group
BGAAWC	Battle Group Antiair Warfare Coordination
BGPHES	Battle Group Passive Horizon Extension System
BIT	Built-in Test
BITE	Built-in Test Equipment
BKS	Broadcast Keying Station
BL	Baseline
BLOS	Beyond Line of Sight
BM	Battle Management
BMA	Battle Management Architecture
BOM	Bit Oriented Message
BPDSMS	Basic Point Defence Surface Missile System
BPS	Bits Per Second
BSES	Boresight Error Slope
BTT	Bank to Turn
BVP	Beacon Video Processor
BWRL	Before Weapon Release Line

C

C2	Command and Control
C2P	Command and Control Processor
C3	Command, Control and Communications
C3CM	Command, Control, Communications Countermeasures
C3I	Command, Control, Communications and Intelligence
C3I/BM	Command, Control, Communications and Intelligence/ Battle Management
C4I	Command, Control, Communications, Computers and Intelligence
CAC	Contact Area Commander
CAD	Computer Aided Design
CAD	Counter ARM Decoy
CAE	Computer Aided Engineering
CAINS	Carrier Aircraft Inertial Navigation System
CAL	Computer Aided Logistics
CALOW	Contingency and Limited Objective Warfare
CAM	Computer Aided Manufacturing
CAP	Combat Air Patrol
CAS	Close Air Support
CAS	Combined Antenna System
CATCC/DAIR	Carrier Air Traffic Control Center/Direct Altitude and Identity Readout
CATF	Commander, Amphibious Task Force
CCA	Carrier Controlled Approach
CCB	Configuration Control Board
CCF	Communications Control Facility
CCFP	Communications Control Facility Processor
CCM	Class Configuration Matrix
CCOW	Channel Control Order Wire
CCS	Combat Control System
CCS	Communications Control Station
CCSC	Cryptologic Combat Support Console
CCSP	Communications Control Station Processor
CCSS	Cryptologic Combat Support System
CCTV	Closed Circuit Television
C&D	Command and Decision
CDB	Contact Data Base
CDF	Combat Direction Finding
CDFC	Combat Direction Finding Communications
CDMA	Code Division Multiple Access
CDPS	Communications Data Processing System
CDS	Combat Direction System
CE	Cooperative Engagement
CEA	Cooperative Engagement Architecture
CEB	CNO Executive Board
CEC	Cooperative Engagement Capability
CEDS	Cooperative Engagement Demonstation System

CEG	Convoy Escort Group
CEP	Cooperative Engagement Processor
CESM	Cryptologic Electronic Support Measures
CEVR	Circular Equivalent Vulnerability Radius
C&F	Cables and Foundations
CHBDL	Common High Band Data Link
CHOJ	Correlation Home On Jam
CIC	Combat Information Center
CID	Cryptologic Interface Device
CIFF	Centralized Identification Friend or Foe
CIGARS	Console Internally Generated and Refreshed Symbology
CINC	Commander in Chief
CIS	Cryptologic Interface Station
CIWS	Close-in Weapon System
CLCU	CUDIXS Link Control Unit
CLF	Commander, Landing Force
CM	Configuration Management
CM	Corrective Maintenance
CM	Countermeasures
CMCS	Communications Monitoring Control System
CMCSS	Cruise Missile Combat Support System
CMP	Cruise Missile Project
CMPO	Cruise Missile Project Office
CMSA	Cruise Missile Support Activity
CMT	Cooperative Mobile Target
CNA	Center for Naval Analyses
CNO	Chief of Naval Operations
CNSG	Commander, Naval Security Group
CO	Commanding Officer
COA	Course of Action
COCC	Contractor Operational Control Center
COM	Character Oriented Message
CORT	Coherent Receiver Transmitter
CP	Computer Programmer
C&P	Characteristics and Performance
CPA	Closest Point of Approach
C&R	Control and Reporting
CRT	Cathode Ray Tube
CS	Combat System
CSA	Combat System Architecture
CSC	Combat System Configuration
CSE	Combat System Engineering
CSLC	Coherent Side Lobe Canceller
CSM	Combat System Matrix
CSMC	Combat System Maintenance Central
CSMIS	Combat System Management Information System
CSOC	Consolidated Space Operations Center
CSOSS	Combat System Operational Sequencing System
CSS	Communications Security System

CSTOM	Combat System Technical Operations Manual
CSTC	Consoidated Satellite Test Center
CTF	Commander, Task Force
CTSL	Central Track Stores Locator
CUDIXS	Common User Digital Information Exchange System
CUP	Class Upgrade Plan
CVBF	Aircraft Carrier Battle Force
CVBG	Aircraft Carrier Battle Group
CVIC	Aircraft Carrier Intelligence Center
CVNS	Aircraft Carrier Navigation System
CWC	Composite Warfare Commander
CWDD	Chemical Warfare Directional Detector
CW	Continuous Wave
CWI	Continuous Wave Illuminator
CY	Calendar Year

D

DAMA	Demand Access Multiple Access
DARPA	Defense Advanced Research Projects Agency
DCA	Defense Communications Agency
DC	Damage Control
DCA	Damage Control Assistant
DCASE	Data Collection, Analysis and Storage Equipment
DCC	Damage Control Central
DCP	Decision Coordinating Paper
DDC	Digital Data Computer
DDI	Digital Display Indicator
DDM	Double Density Memory
DDN	Defense Data Network
DDS	Data Distribution System
DECM	Deceptive Electronic Countermeasures
D/F	Direction Finder
DF	Direction Finding
DIA	Defense Intelligence Agency
DIN	Data Index Number
DIN/DSSC	Digital Information Network/Defense Special Security Communications System
DINS	Dual Inertial Navigation System
DLCS	Data Link Communication System
DLI	Deck Launched Interceptor
DLRP	Data Link Reference Point
DLS	Decoy Launching System
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
DODIIS	Department of Defense Intelligence Information System
DOP	Development Options Paper
DPSK	Differential Phase-Shift Keying
DRP	Data Retrieval Program

DSARC	Defense Systems Acquisition Review Council
DSAT-T	Developmental Submarine Analysis Tool Terminal
DSCS	Defense Satellite Communications System
DSD	Digital Sharing Device
DSI	Dissimilar Source Integration
DSMAC	Digital Scene Matching Area Correlation
DSP	Defense Support Program
DSP	Digital Signal Processor
DT	Development Test
DTAF	Dynamic Tactical Area File
DTC	Desk-Top Computer
DTDMA	Distributed Time Division Multiple Access
DT&E	Development Test and Evaluation
DTS	Data Terminal Set
D&V	Demonstration and Validation
DVC	Direct View Console

E

EAM	Emergency Action Message
EATS	Extended Area Tracking System
ECCM	Electronic Counter-Countermeasures
ECM	Electronic Countermeasures
ECMU	Extended Core Memory Unit
ECP	Engineering Change Proposal
ECS	External Communications System
EDAC	Error Detection and Correction
EDM	Engineering Development Model
E3	Electromagnetic Environmental Effects
EEPROM	Electronically Erasable Programable Read Only Memory
EHF	Extremely High Frequency
EIRP	Effective Isotropic Radiated Power
ELOS	Extended Line of Sight
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMI	Electomagnetic Interference
EMP	Electromagnetic Pulse
EO	Electo-Optical
EOB	Electronic Order of Battle
EOFCSS	Electro-Optical Fire Control System (SEAFIRE)
EOOB	Electronic Order of Battle
EOSS	Engineering Operational Sequencing System
ER	Extended Range
ERP	Effective Radiated Power
ESA	European Space Agency
ESL	Expected Service Life
ESM	Electronic Support Measures
ESR	Electronically Scanned Radar

EW	Electronic Warfare
EWC	Electronic Warfare Coordinator
EWCM	Electronic Warfare Coordination Module
EWCM	Electronic Warfare Countermeasures
EWCS	Electronic Warfare Control System

F

FAAD	Forward Area Air Defense
FAAWC	Force AAW Commander
FAROES	Fleet Automatic Reconstruction and Opportunity Evaluation System
FASUWC	Force ASUW Commander
FASWC	Force ASW Commander
FC	Fire Control
FCC	Fleet Command Center
FCCBMP	Fleet Command Center Battle Management Program
FCS	Fire Control System
FDDS	Flag Data Display System
FDMA	Frequency Division Multiple Access
FEDS	Flight Experience Data System
FEWC	Force Electronic Warfare Coordinator
FEWSG	Fleet Electronic Warfare Support Group
F2D2	Functional Flow Diagram and Description
FHLT	Force High Level Terminal
FIC	Fleet Intelligence Center
FIST	Fleet Imagery Support Terminal
FL	Fully Loaded
FLD	Full Load Displacement
FLIR	Forward Looking Infrared
FLTCINC	Fleet Commander in Chief
FLTNBSV	Fleet Narrowband Secure Voice
FM	Frequency Modulation
FMA	Field Maintenance Agent
FMF	Fleet Marine Force
FMFP	Fleet Marine Force Publication
FMOS	Formatted Message Originating System
FMP	Fleet Modernization Program
FNOC	Fleet Numerical Oceanographic Center
FO	Fitting Out
FOC	Full Operational Capability
FOM	Figure of Merit
FOSIC	Fleet Ocean Surveillance Information Center
FOSIF	Fleet Ocean Surveillance Information Facility
FOTC	Force OTH-T Track Coordinator
FOT&E	Follow-On Test and Evaluation
FP	Forward Pass
FPP	Forward Pass Platform

FSB	Fleet Satellite Broadcast
FSCS	Fleet Satellite Communications System
FSD	Full-Scale Development
FSED	Full-Scale Engineering Development
FSEP	Force System Engineering Plan
FSK	Frequency-Shift Keying
FSM	Fleet Satellite Communications Spectrum Monitor
FSO	Fleet Support Operations
FSP	Federated Support Processor
FSTC	Force Surface Track Coordinator
FTA	Force Track Alignment
FTAS	Fast Time Analysis System
FTC	Force Track Coordinator
FTN	Force Track Number
FY	Fiscal Year
FYDP	Five Year Defense Plan

G

GADS	Geographic/Alphanumeric Display System
GATS	General Access Time Slot
G&C	Guidance and Control
GCI	Ground Controlled Intercept
GCS	Gun Computing System
GDS	Gridlock Data System
GFCP	Generic Front-End Communications Processor
GFCS	Gun Fire Control System
GFE	Government Furnished Equipment
GFI	Government Furnished Information
GGS	Geodetic Gridlock System
GLCM	Ground Launched Cruise Missile
GLOBIXS	Global Information Exchange System
GMF	Ground Mobile Forces
GMFCS	Guided Missile Fire Control System
GMLS	Guided Missile Launching System
GMT	Greenwich Mean Time
GPS	Global Positioning System
GPSCS	General Purpose Satellite Communications System
GRU	Gridlock Reference Unit

H

HARDI	Hawkeye Airborne Recording Digital Instrumentation
HARPSS	High Altitude Remotely Piloted Surveillance System
HARS	Heading and Altitude Reference System
HERO	Hazards of Electromagnetic Radiation to Ordnance
HF	High Frequency
HFAJ	High Frequency Antijam
HFDF	High Frequency Direction Finding

HHR	High Hop Rate
HIFR	Helicopter In-Flight Refueling
HIMAD	High to Medium Altitude Air Defense
HIT	High Interest Target
HK	Hard Kill
HK/SK	Hard Kill/Soft Kill
HLCS	Harpoon Launch Control System
HLT	High Level Terminal
HM&E	Hull, Mechanical and Electrical
HMI	Human-Machine Interface
HOJ	Home on Jam
HPA	High Power Amplifier
HPS	Hops Per Second
HSP	High Speed Printer
HTACC	Hardened Tactical Air Control Centers
HULTEC	Hull to Emitter Correlation
HVAC	Heating, Ventilation and Air Conditioning

I

IAB	Inner Air Battle
IACS	Integrated Acoustic Communications System
IADT	Integrated Automated Detection and Tracking
IAIPS	Integrated Automated Intelligence Processing System
IAW	In Accordance With
IC	Intelligence Center
ICAPS	Integrated Carrier Antisubmarine Warfare Prediction System
ICS	Integrated Communications System
ICW	Interrupted Continuous Wave
IDHS	Intelligence Data Handling System
IDMS	Improved Deep Moored Sweep
IDPS	Intelligence Data Processing System
IDS	Interface Design Specification
IDSCP	Initial Defense Satellite Communications Program
IDSCS	Initial Defense Satellite Communications System
IF	Intermediate Frequency
IFF	Identification, Friend or Foe
IG	Inspector General
IG	Interconnecting Group
ILS	Instrument Landing System
ILS	Integrated Logistics Support
ILSS	Integrated Logistic Support Summary
IM	Insensitive Munitions
IMS	Influence Minesweeping
IMU	Inertial Measuring Unit
INS	Inertial Navigation System
IO	Indian Ocean
I/O	Input/Output

IOC	Initial Operational Capability
IPDSMS	Improved Point Defense Ship Missile System
IPS	Integrated Program Summary
IR	Infrared
IRA	Interface Requirements Analysis
IRCM	Infrared Countermeasures
IRD	Interface Requirements Document
IRGP	Infrared Guided Projectile
IRR	Integral Ramjet Rocket
IRS	Interface Requirements Specification
IRST	Infrared Search and Track
IRSTD	Infrared Search and Target Detection
ISABPS	Integrated Submarine Automated Broadcast Processing System
ISAR	Inverse Synthetic Aperture Radar
ISE	Independent Steaming Exercise
ISG	Intelligence Support Group
ISPS	Integrated Strike Planning System
IT	Information Transfer
ITA	International Telegraphic Alphabet
ITA-2	International Telegraphic Alphabet (American Varia tion
ITAWDS	Integrated Tactical Amphibious Warfare Data System
ITDA	Intrim Tactical Decision Aid
IU	Interface Unit
IUSS	Integrated Undersea Surveillance System
IVDS	Independent Variable Depth Sonar
I&W	Indications and Warning
IWS	Integrated Work Station
IXS	Information Exchange System

J

JANAP	Joint Army, Navy and Air Force Procedures
JCMPO	Joint Cruise Missile Project Office
JCS	Joint Chiefs of Staff
JIC	Joint Intelligence Center
JINTACCS	Joint Interoperability of Tactical Command and Control Systems
JMSNS	Justification for Major System New Start
JOPES	Joint Operations Planning and Execution System
JOTS	Joint Operational Tactical System
JPO	Joint Project Office
JPTDS	Joint Participating Tactical Data System
JRMB	Joint Requirements and Management Board
JSCAMPS	Joint Service Common Airframe Multiple Purpose System
JSIPS TIS	Joint Service Image Processing System Tactical Intelligence System
JTIDS	Joint Tactical Information Distribution System
JU	JTIDS Unit

K

L

LADAR	Laser Detection and Ranging
LAMPS	Light Airborne Multipurpose System
LAN	Local Area Network
LAR	Launch Acceptable Region
LASER	Light Amplification by Stimulated Emission of Radiation
LASS	Low Altitude Surveillance System
LCAC	Landing Craft, Air Cushion
LCC	Life Cycle Cost
LCS	Launcher Control System
LEC	LAMPS Element Coordinator
LEIP	Link 11 Improvement Program
LF	Landing Force
LFM	Landing Force Manual
LFOC	Landing Force Operation Center
LHR	Low Hop Rate
LIC	Limited Intensity Conflict
LLL-TV	Low Light Level Television
LLS	Low Level Serial
LO	Low Observable
LOAL	Lock-On After Launch
LOB	Line of Bearing
LOBL	Lock-On Before Launch
LOI	Letter of Instruction
LORAN	Long Range Navigation
LOROP	Long Range Oblique Photography
LOS	Line of Sight
LPD	Low Probability of Detection
LPE	Low Probability of Exploitation
LPI	Low Probability of Intercept
LR	Long Range
LRAACA	Long Range Air Antisubmarine Warfare Capability Aircraft
LRCCM	Long Range Conventional Cruise Missile
LRI	Limited Range Intercept
LRIP	Low Rate Initial Production
LRO	Link 11 Receive Only
LRU	Line Replaceable Unit
LSA	Logistic Support Analysis
LSC	Lead Systems Command
LSD	Large Screen Display
LSI	Large Scale Integration
LSM	Loader Select Modification

M

MAB	Marine Amphibious Brigade
MADT	Mean Administative Delay Time
MAGIS	Marine Air Ground Intelligence System
MASS	Major ADP Support System
MAU	Marine Amphibious Unit
MBA	Multiple-Beam Antenna
MBC	Meteor Burst Communications
MBCS	Meteor Burst Communications System
MCAR	Multichannel Acoustic Relay
MDS	Mission Display System
MDT	Mean Delay Time
MDU	Mission Data Update
MEB	Marine Expeditionary Brigade
MEC	Minimum Essential Communications
MEF	Marine Expeditionary Force
MEU	Mission Essential Unit
MFAR	Multifunction Array Radar
MFCS	Missile Fire Control System
MGS	Movable Ground Station
MHS	Mine Hunting Sonar
MIA	Mutual Interface Avoidance
MILES	Multimedia Improved Link 11 System
MIMS	Modular Influence Minesweeping System
MINI-SARS	Mini-Shipboard Automatic Recorder System
MIRACL	Mid-Infrared Advanced Chemical Laser
MIS	Management Information System
MIW	Mine Warfare
ML	Missile Launcher
MLDT	Mean Logistics Delay Time
MLSF	Maritime Logistics Support Force
MLV	Medium Launch Vehicle
MMG	Multimode Guidance
MMI	Man-Machine Interface
MNS	Mine Neutralization System
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MOU	Memorandum of Understanding
MPA	Maritime Patrol Aircraft
MPC	Mission Planning Center
MPDS	Message Processing and Distribution System
MPS	Message Processing System
MR	Medium Range
MRRPV	Mid-Range Remotely Piloted Vehicle (being redesignated as JSCAMPS)
MRS	Mini-Reconstruction System
MRT	Miniature Receive Terminal
MSC	Military Sealift Command

MSH	Mine Sweeper, Hunter
MSO	MILSATCOM Systems Office
MSO	Mine Sweeper, Ocean
MSR	Mobile Sea Range
MSU	Modem Sharing Unit
MTACCS	Marine Tactical Amphibious Command and Control System
MTBF	Mean Time Between Failures
MTF	Message Text Format
MTST	Maneuvering Target Statistical Tracker
MTTR	Mean Time To Repair
MUSIC	Multiple Uses Special Intelligence Communications
MUTE	Multiplex Unit for Transmission Elimination

N

NACISA	NATO Communications and Information Systems Agency
NATO	North Atlantic Treaty Organization
NAVCAMS	Naval Communications Area Master Station
NAVCOMPARS	Naval Communications Processing and Routing System
NAVMACS	Naval Modular Automated Communications System
NAVSSI	Navigation Sensor Systems Integration
NB	Narrow Band
NC	New Constuction
NCA	National Command Authority
NCAPS	Naval Control and Protection of Shipping
NCC	Navy Command Center
NCCS	Naval Command and Control System
NCEA	Navy Cooperative Engagement Architecture
NCO	Net Control Officer
NCS	Net Control Station
NDRO	Non-Destructive Readout
NEDN	Naval Environmental Data Network
NEDS	Naval Environmental Display System
NES	Navigation and Environmental Support
NESP	Navy EHF SATCOM Program
NESS	Navy EHF SATCOM System
NFC	Numbered Fleet Commander
NFCC	Numbered Fleet Command Center
NFR	NATO Frigate Replacement
NGFS	Naval Gun Fire Support
NIAC	Naval Intelligence Automation Command
NIPS	Naval Intelligence Processing System
NIS	National Information System (Military Command)
NMCC	National Military Command Center
NMD	Normalized Miss Distance
NMIC	National Military Intelligence Center
NOIC	Naval Operational Intelligence Center
NOMSS	Navy Oceanographic and Meteorological Support System

NOPF	Naval Ocean Processing Facility
NOSIC	Navy Ocean Surveillance Information Center
NRF	Naval Reserve Force
NRT	Non-Real Time
NSA	National Security Agency
NSFS	Naval Surface Fire Support
NSG	Naval Security Group
NSO	Normal Sustained Operations
NSOF	Naval Status of Forces
NSSMS	NATO Seasparrow Surface Missile System
NSW	Naval Special Warfare
NTCOC	Naval Telecommunications Command Operations Center
NTDS	Naval Tactical Data System
NTE	Not To Exceed
NTP	Naval Telecommunications Procedures
NTR	Network Time Reference
NTS	Naval Telecommunications System
NTU	New Threat Upgrade
NWIP	Naval Warfare Information Publication
NWP	Naval Warfare Publication
NWSS	Navy WWMCCS Support System
NWTDB	Naval Warfare Tactical Data Base

O

O/A	Ordnance Alteration (ORDALT)
OAB	Outer Air Battle
OABWS	Outer Air Battle Weapon System
OADR	Originating Agency Determination Required
OB	Outboard
OBS	OSIS Baseline System
OBU	OSIS Baseline Update
OCC	Operations Control Center
OCE	Officer Conducting the Exercise
ODD	Offboard Deception Device
OLSS	Operational Logistic Support Summary
OMB	Office of Manpower and Budget
ONR	Office of Naval Research
OOB	Order of Battle
OR	Operational Requirement
ORTS	Operational Readiness Test System
O&S	Operations and Support
OSD	Office of the Secretary of Defense
OSG	Operations Support Group
OSIS	Ocean Surveillance Information System
OSP	Ocean Surveillance Product
OSS	Operations Support System
OT	Operational Test

OTC	Officer in Tactical Command
OTCIXS	Officer in Tactical Command Information Exchange System
OTG	OTH-T Gold (Message)
OTH	Over the Horizon
OTH-B	Over the Horizon-Backscatter
OTH-DC&T	Over the Horizon-Detection, Classification & Tracking
OTH-T	Over the Horizon-Targeting
OTL	Operational Test Launch

P

Pk	Probability of Kill
Pkss	Probability of Kill-Single Shot
PACT	Prototype Afloat Correlation Tracker
PAR	Phase Array Radar
PASU	Preliminary Approval for Service Use
PAWS	Prototype Analyst Work Station
PCM	Pulse Coded Modulation
PDA	Principal Development Agency
PDIP	Preflight Data Insertion Program
PDS	Passive Detection System
PEC	Passive Equipment Cabinet
PHM	Guided Missile Patrol Combatant (Hydrofoil)
PHST	Packaging, Handling, Storage and Transportation
PID	Preflight Insertion Data
PI/DE	Passive Identification and Direction Equipment
PIF	Personal Identification Feature
PIM	Position and Intended Movement
PINS	Precise Integrated Navigation System
PIP	Predicted Intercept Point
PIP	Product Improvment Program
PIRAZ	Positive Identification Radar Advisory Zone
PLI	Position Location Information
PLRS	Precision Location Reporting System
PM	Performance Monitoring
PM	Preventive Maintenance
PM	Program Manager
PMD	Perpendicular Miss Distance
PMI	Proposed Military Improvement
PMP	Program Management Proposal
PMS	Planned Maintenance System
POA&M	Plan of Action and Milestones
POM	Program Objective Memorandum
POST	Prototype Ocean Surveillance Terminal
PPBS	Planning, Programming and Budget System
PPM	Pre-Production Model
P3I	Pre-Planned Product Improvement
PRF	Pulse Repetition Frequency
PRI	Pulse Repetition Interval

PROM	Programmable Read-Only Memory
PRTS	Priority-Request Time Slot
PS	Platform Support
PSA	Post Shakedown Availability
PSK	Phase-Shift Keying
PSU	Port Sharing Unit
PTI	Proposed Technical Improvement
PTMS	Prototype Track Management System
PU	Participating Unit
PW	Pulse Width

Q

QRFI	Quick Reaction Fleet Improvement

R

RADAR	Radio Detection and Ranging
RAIDS	Rapid Antiship Missile Integrated Defense System
RAM	Rolling Airframe Missile
RAST	Recovery Assist, Securing and Traversing System
RATS	Random Access Time Slots
RB	Report Back
RBOC	Rapid Blooming Offboard Chaff
RCCOW	Return Channel Control Order Wire
RCS	Radar Cross Section
R&D	Research and Development
RDF	Radio Direction Finding
RDP	Radar Display Processor
RDSS	Radio Determination Satellite System
RDT&E	Research and Development Test and Evaluation
RF	Radio Frequency
RFG	Rainform Gold
RFI	Radio Frequency Interference
RIB	Radio Interface Buoy
RIIXS	Remote Interrogation Information Exchange Subsystem
RIM	ROTHR Interface Module
RM	Resource Management
RMS	Reconnaissance Management System
RMS	Root Mean Square
RNTDS	Restructured Naval Tactical Data System
RO	Reduced Observability
ROC	Required Operational Capability
ROE	Rules of Engagement
ROF	Required Operational Function
ROH	Regular Overhaul
ROU	Radius of Uncertainty
ROTHR	Relocatable Over the Horizon Radar
RPV	Remotely Piloted Vehicle

RRC	Regional Reporting Center
RRI	Remote-Request Interface
RRP	Radar Receiver Processor
RSS	Radar Signal Simulator
RT	Radio Transmitter
RTLOS	Remote Track Launch on Search
RTS	Remote Tracking Station
RTT	Radio Teletype
RVP	Radar Video Processor
R/W/B	Red/White/Blue

S

SA	Semiactive
SAC	Strategic Air Command
SACC	Shore ASW Command Center
SAG	Surface Action Group
SAL-GP	Semi-Active Laser-Guided Projectile
SAM	Surface-to-Air Missile
SAMIS	Ship Alteration Management Information System
SAR	Search and Rescue
SARS	Shipboard Automatic Recorder System
SAS	Single Audio System
SAU	Search Attack Unit
SBR	Space Based Radar
SC	Screen Coordinator
SCC	System Coordinate Center
SCCM	Ship's Cryptologic Countermeasures
SCCP	Satellite Communications Control Processor
SCF	Satellite Control Facility
SCI	Sensitive Compartmented Information
SCI	Special Compartmented Intelligence
SCICP	SCI Communications Processor
SCN	Ship Construction, Navy
SCS	Satellite Control Site
SCT	Single Channel Transponder
SDI	Strategic Defense Initiative
SDMS	Shipboard Data Multiplex System
SDS	Satellite Data System
SDS	Surveillance Direction System
SEAL	Sea, Air and Land (Forces)
SEC	Space and Electronic Combat
SEC	Submarine Element Coordinator
SECAS	Ship Equipment Configuration Accounting System
SELOR	Ship Emitter Locator Report
SEP	Spherical Error of Probability
SGS	Shipboard Gridlock System
SHF	Super High Frequency
SI	Special Intelligence

SIC	Subject Identifier Code
SIDS	Sensor Interface Display System
SIF	Selective Identification Feature
SIMAS	Sonar In-Situ Mode Assessment System
SINCGARS	Single Channel Ground to Air Radio System
SINS	Ship's Inertial Navigation System
SIOP	Single Integrated Operation Plan
SIU	Sensor Interface Unit
SK	Soft Kill
SLCM	Sea Launched Cruise Missile
SLED	Ship Launched Electronic Decoy
SLEP	Service Life Extension Program
SLGR	Small Lightweight GPS Receiver
SNDL	Standard Navy Distribution List
SM	Standard Missile
SMD	System Milestone Data
SMOOS	Shipboard Meteorological and Oceanographic Observation System
SMRAALS	Shipboard Marine Remote Approach Area Landing System
SNR	Satellite Navigation Receiver
SOC	Satellite Operations Center
SOC	System Operational Concept
SOCC	Submarine Operations Command Center
SOF	Status of Forces
SOI	Signal of Interest
SOJ	Standoff Jammer
SOL	Sequence Order List
SONAR	Sound Navigation and Ranging
SOP	Standard Operating Procedure
SOR	Statement of Requirements
SOSS	Soviet Ocean Surveillance System
SPA	SOSUS Probability Area
SPAR	System Performance and Retrieval
SPIE	Ship's Precise Identification by Emitter
SPS	Symbols per Second
SPW	Special Warfare
SRA	Selected Restricted Availability
SRAM	Short Range Attack Missile
SRBOC	Super Rapid Blooming Offboard Chaff
SS	Surface Search
SSCSMP	Surface Ship Combat System Master Plan
SSDS	Single Ship Deep Sweep
SSES	Ship's Signal Exploitation Space
SSI	Similar Source Integration
SSIC	Standard Subject Identification Code
SSIXS	Submarine Satellite Information Exchange System
SSMA	Spread Spectrum Multiple Access
SSS	Strategic Satellite System
SSTD	Surface Ship Torpedo Defense

SSTS	Space Surveillance and Tracking System
STC	Space Test Center
STIR	Separate Track and Illumination Radar
STM	Service Test Model
STN	System Track Number
STS	Space Transportation System
STT	Shore Targeting Terminal
STT	Skid to Turn
STW	Strike Warfare
STWC	Strike Warfare Commander
SURPAC	Surface Plotting and Chart System
SURTAS	Surveillance Towed Array Sonar
SURTASS	Surface Towed Array Surveillance System
SUS	Sound Underwater Signal
SV	Secure Voice
SVGC	Secure Voice and Graphics Conferencing
SVIP	Secure Voice Improvement Program
SVT	Satellite Voice Terminal
SVTT	Surface Vessel Torpedo Tube

T

TAC	Tactical Aircraft
TAC	Target Acquisition Console
TACCIMS	Theater Automated Command and Control Information Management System
TACCS	Theater Automated Command and Control System
TACTAS	Tactical Towed Array System
TADIL	Tactical Digital Information Link
TADIXS	Tactical Data Information Exchange System
TAMPS	Tactical Air Mission Planning System
TAO	Tactical Action Officer
TARPS	Tactical Aerial Reconnaissance Pod System
TAS	True Airspeed
TASM	Tomahawk Antiship Missile
TASS	Towed Array Surveillance System
TBD	To Be Determined
TBS	To Be Supplied
TCO	Tactical Combat Operations
TCP	Terminal Control Processor
TCS	Tactical Command System
TDDS	Tactical Data Display System
TDM	Time Division Multiplexed
TDMA	Time Division Multiple Access
TDOC	Temporary Definition of Convenience
TDP	Tactical Data Processor
TDRSS	Tracking and Data Relay Satellite System
TDS	Tactical Data System
T&E	Test and Evaluation

TEMP	Test and Evaluation Master Plan
TEPEE	Tomahawk Engagement Planning and Exercise Evaluation
TESP	Tomahawk Environmental Support Product
TESS	Tactical Environmental Support System
TEWA	Threat Evaluation and Weapon Assignment
TFCC	Task Force Command and Control
TFCC	Tactical Flag Command Center
TGA	Track Generation System
TGS	Track General Software
TIB	Technical Information Base
TIDP	Technical Interface Design Plan
TIMD	Tactical Information Management and Display
TIMS	Tactical Information Management System
TIPS	Tactical Information Processing System
TLAM	Tomahawk Land Attack Missile
TLR	Top Level Requirements
TLWR	Top Level Warfare Requirement
TMA	Target Motion Analysis
TMP	TACINTEL Message Processor
TMPC	Theater Mission Planning Center
TMPS	Theater Mission Planning System
TOC	Time of Completion
TOD	Time of Decision
TOE	Time of Event
TOL	Time of Launch
TOLO	Time of Launch Order
TOLR	Time of Launch Request
TOPAS	Tactical Operational Performance Assessment System
TOR	Tentative Operational Requirement
TOR	Time of Receipt
TOSP	Tailored Ocean Surveillance Product
TOT	Time of Transmission
TOT	Time on Target
TPQ	Tracking Picture Quality
T/R	Transmit/Receive
TRE	Tactical Receive Equipment
TRS	Tactical Reconnaissance System
TSAM	Tomahawk Surface Attack Missile
TSC	Tactical Support Center
TSES	Tactical Signals Exploitation System
TSTWCCS	Tomahawk Strike Warfare Command and Control System
TT&C	Telemetry, Tracking and Command
TVC	Thrust Vector Control
TVLSC	Tomahawk Vertical Launching System Canister
TWCS	Tomahawk Weapon Control System
TWS	Tomahawk Weapon System
TWT	Travelling-Wave Tube

U

UAV	Unmanned Air Vehicle
UFCS	Underwater Fire Control System
UFO	UHF Follow-On
UFO	Unidentified Flying Object
UHF	Ultra-High Frequency
UNT	Unified Networking Technology
URG	Underway Replenishment Group
USAF	United States Air Force
USMC	United States Marine Corps
UTE	Unimpaired Tactical Effectiveness
UTIPS	Upgraded Tactical Information Processing System
UTM	Universal Test Message
UU	User Unit
U/W	Underwater
UWS	Underwater Weapons System
UWS	Universal Work Station

V

VAD	Vulnerability Assessment Device
VCS	Video Clutter Suppression
VDS	Variable Depth Sonar
VFCT	Voice-Frequency Carrier Telegraph
VHF	Very High Frequency
VHSIC	Very High Speed Integrated Circuit
VIDS	Visual Interactive Display System
VIP	Visual Information Processing
VL	Vertical Launch
VLA	Vertical Launched ASROC
VLF	Very Low Frequency
VLS	Vertical Launching System
VLSI	Very Large Scale Integration
VOX	Voice-Operated Relay (Switch)
VSAT	Very Small Aperture Terminal

W

WAC	Warfare Area Commander/Coordinator
WAC	Warfare Area Control
WAP	Weapons Alternate Processor
WAS	War at Sea
WAS	Wide Area Surveillance
WB	Wide Band
WBE	Wide Band Elements
WC	Warfare Coordinator
WCC	Weapon Control Console
WCP	Weapon Control Panel

WCS	Weapons Control System
WDE	Weapons Direction Equipment
WDS	Weapons Direction System
WIS	WWMCCS Information System
WL	Waterline
WMA	Warfare Mission Area
WMO	World Meteorological Office
WMSA	Warfare Mission Support Area
WPN	Weapon Procurement, Navy
WRD	Weapon Release Distance
WRL	Weapon Release Line
WRR	Weapon Release Range
WSA	Warfare System Architecture
WSA&E	Warfare System Architecture and Engineering
WSE	Warfare System Engineering
WSF	Warfare System Function
WSMA	Warfare Support Mission Area
WSO	Weapon System Officer
WSP	Weapon Support Processor
WSS	Warfare Support System
WWMCCS	Worldwide Military Command and Control System

X

Y

Z

APPENDIX B

A DEFINITIVE TASK FORCE LEVEL NAVY COOPERATIVE ENGAGEMENT FUNCTIONAL ARCHITECTURE

By
Carl M. Bennett
Naval Coastal Systems Center

TECHNICAL
WORKING PAPER
NCSC 10T-90-1

APRIL 1990

A DEFINITIVE TASK FORCE LEVEL NAVY COOPERATIVE ENGAGEMENT FUNCTIONAL ARCHITECTURE

CARL M. BENNETT

NAVAL COASTAL SYSTEMS CENTER

PANAMA CITY, FLORIDA 32407-5000

A DEFINITIVE TASK FORCE LEVEL NAVY COOPERATIVE ENGAGEMENT FUNCTIONAL ARCHITECTURE

by
Carl M. Bennett, Head
Senior Analyst Office
Warfare Analysis Department
Naval Coastal Systems Center
Panama City, Florida 32407-5000

25 April 1990

"Form Follows Function" - Frank Lloyd Wright

1. This paper addresses the Navy Cooperative Engagement Architecture [NCEA] Terms of Reference items (c) and (d) , and Approach item (a) [1]. The paper is an individual assignment deliverable, of SPAWAR 31A Task 31A-003 [2].

2. The paper utilizes the concepts and definitions of NWP-1(Rev. A) [3]. The development of the NCEA functional processes is derived from several sources, notability unpublished SPAWAR 31 documents [4 5 6], Air University Press Research Report, AU-ARI-82-5 [7], and an SAIC draft report [8]. The Computer Aided Systems Engineering [CASE] methodology used in the development of the subject Task Force level Navy cooperative engagement functional architecture is found in

---

[1] "Navy Cooperative Engagement Architecture Terms of Reference", enclosure (1), "Navy Cooperative Engagement Architecture", SPAWAR Letter 3050, Ser 31/131, 2 Nov 89, (U).
[2] "SPAWAR 31A Task 31A-003 of 30 Mar 90", enclosure (1), Cooperative Engagement Architecture", SPAWAR Letter 3900, Ser 30P/82, 3 Apr 1990, (U).
[3] "Strategic Concepts of the U. S. Navy NWP-1 (Rev. A), Chief of Naval Operations, May 1978, (U).
[4] "Descriptions of The ASW Architecture Methodology" unpublished SPAWAR 315 working paper, 11 May 1988 (U).
[5] "Generation of Force Performance Metrics from Required Operational Functional Data" unpublished SPAWAR 31FL6 working paper, Carl M. Bennett, 19 January 1989, (U).
[6] "Revised Master Generic Set of Required Operational Functions (ROFs) to be Accomplished by a CVBF" SPAWAR 31F1 informal document, [William T. Crawford, APL/JHU], 15 December 1988, (U).
[7] "Combat Operations C3I Fundamentals and Interactions" Air Power Research Institute, Research Report AU-ARI-82-5, George E. Orr, Major, USAF, Air University Press, Maxwell Air Force Base, Alabama, July 1983, (U).
[8] "Hierarchy of Objectives: An Approach to Command and Control Warfare Requirements" SAIC Comsystems Division draft report 1641-06-A005, [Paul Girard], 15 December 1989, (U).

several texts, e.g.[1] [2]. The CASE tool used is the SPAWAR 31 de-facto standard, Design/IDEF 1.5[3] executed on a Macintosh computer. The framework for the Design/IDEF Data Flow Diagram documentation of the Task Force level Navy cooperative engagement functional architecture is based on prior NCEA task efforts by the author[4].

3. Task Force level Navy cooperative engagement is viewed here as a multi-warfare, warfighting process. It includes all twelve of the Warfare Tasks, i.e. AAW, ASW, ASUW, STW, AMW, MIW, NSW, SURV, INTEL, C3, EW; LOG, and the Naval Warfare Areas of Surface, Submarine, and Air of NWP-1 (Rev. A)[5].It is expected to include the additional Warfare Tasks of Electronic Combat , EC, and Anti-space Warfare, ASPW, and the Naval Warfare Area, Space.

4. This paper addresses a Task Force high level Navy cooperative engagement process [TFCE] encompassing all the Warfare Tasks, and Warfare Areas above, with a focus on the decomposition of the functions of Air and Surface AAW in general and Air AAW in particular. The framework of the definitive NCEA presented below in the form of a Design/IDEFo, data flow diagram, structured analysis, functionally defines a fully capable Task Force Navy cooperative engagement process. The detailed functional decomposition, however, focuses on AAW in general and Air AAW specifically. Expansion of the "trimmed" / "incomplete" functional decomposition branches utilizing the paradigm of the fully developed Air AAW decomposition is seen as straight forward.

5. The context of the Task Force level Navy cooperative engagement process [TFCE] is illustrated in Appendix A, page P-1. In this context the NCEA is viewed as a warfighting process. The TFCE process "inputs" potential targets ["Targets"] and processes these "Targets" producing "outputs": Defeated Enemy Targets, Unmolested Friendly "Targets"; Undamaged Neutral "Targets". The process is controlled by Doctrine and Mission Directives from higher authority, and by Environmental Constraints from "Mother Nature". The TFCE process is a structured functional decomposition for NCEA. It can be implemented by various physical material forms, e.g. physical architectures, organizational structures, manning schemes, etc. The level "0" TFCE process implementation mechanisms are Assigned Physical Resources / Materials and Supporting Physical Resources / Materials. This Design/IDEF feature allows a mapping between the physical / material / organizational components of a physical NCEA and the functional NCEA presented in Appendix A. This mapping is omitted here. It can be added later for a given physical architecture, i.e. implementation option.

---

[1] Structure Analysis and Design Techniques , David Marca and Clement McGowan, McGraw Hill, ISBN # 0-07-040235.

[2] Modern Structured Analysis, Edward Yourdon, Yourdon Press , Prentice Hall, ISBN # 0-13-598624-9, 1989.

[3] "Design/IDEF 1.5", Meta Software Corporation, Cambridge, MA.

[4] " A Task Force Cooperative Warfighting Architecture Top Down Analysis Framework" documented NCEA Team viewgraph report, Carl M. Bennett, Naval Coastal Systems Center, Panama City, Florida, 26 January 1990, (U).

[5] Pages 1-4-2, 1-4-3, "Strategic Concepts of the U. S. Navy NWP-1 (Rev. A), Chief of Naval Operations, May 1978, (U).

6. Design/IDEF is more than a set of drawings. It is a data base of functional processes and and associated data flows . Appendix A is a pictorial presentation of the TFCE data base. Appendix B is a functional processes Activity Report presentation of the TFCE data base. It is generated automatically as a word processing compatible document upon request. For each TFCE functional process decomposition level, i.e. "Activity", the "Activity" data flow "Inputs", "Outputs", "Controls", and "Mechanisms" are listed. Associated "Sub-Activities", i.e. sub-functional processes, are also listed. Notice that the "Mechanisms" below the level "0" are listed as (None), i.e. the physical to functional architecture mapping has been omitted. Later when a physical system capability is assigned to the implementation of a given "Activity" (TFCE function), the Appendix B type Activity Report will explicitly show the desired physical to functional architecture mapping for a physical architectural implementation option. Likewise, the Appendix C Arrow Decomposition Report maps the relationship of a given "Arrow" (TFCE data flow) to the TFCE process "Activities" and other "Arrows". This report is also generated automatically as a word processing compatible document upon request. Appendix D is a Full IDEFo Report of the "Arrow" and "Activities" inter-relationships. This report is also generated automatically as a word processing compatible document upon request.

7. This functional NCEA, in the form of a Design/IDEF data flow diagram structured analysis, has not been verified or validated by peer review. It has been verified by the Design/IDEF CASE tool for logical consistency as indicated by the Consistency Report of Appendix A. The review stages of Draft Review, Recommended Review, and Publication Review remain to be done as indicated on the drawings, pages P1-P17 of Appendix A. This working paper does, however, illustrate the utility of Design/IDEF as a tool for the development, documentation, and configuration management of a functional NCEA with the facility of explicitly documenting a mapping between the functional NCEA and a given physical NCEA option.

APPENDIX A: Design/IDEFo Data Flow Diagram Structured Analysis for NCEA

I. Consistency Report for NCEA Mod 4.0 Full Draft-1 of 24 April 1990

All External Labels Are Connected

All Activities Have a Control Arrow

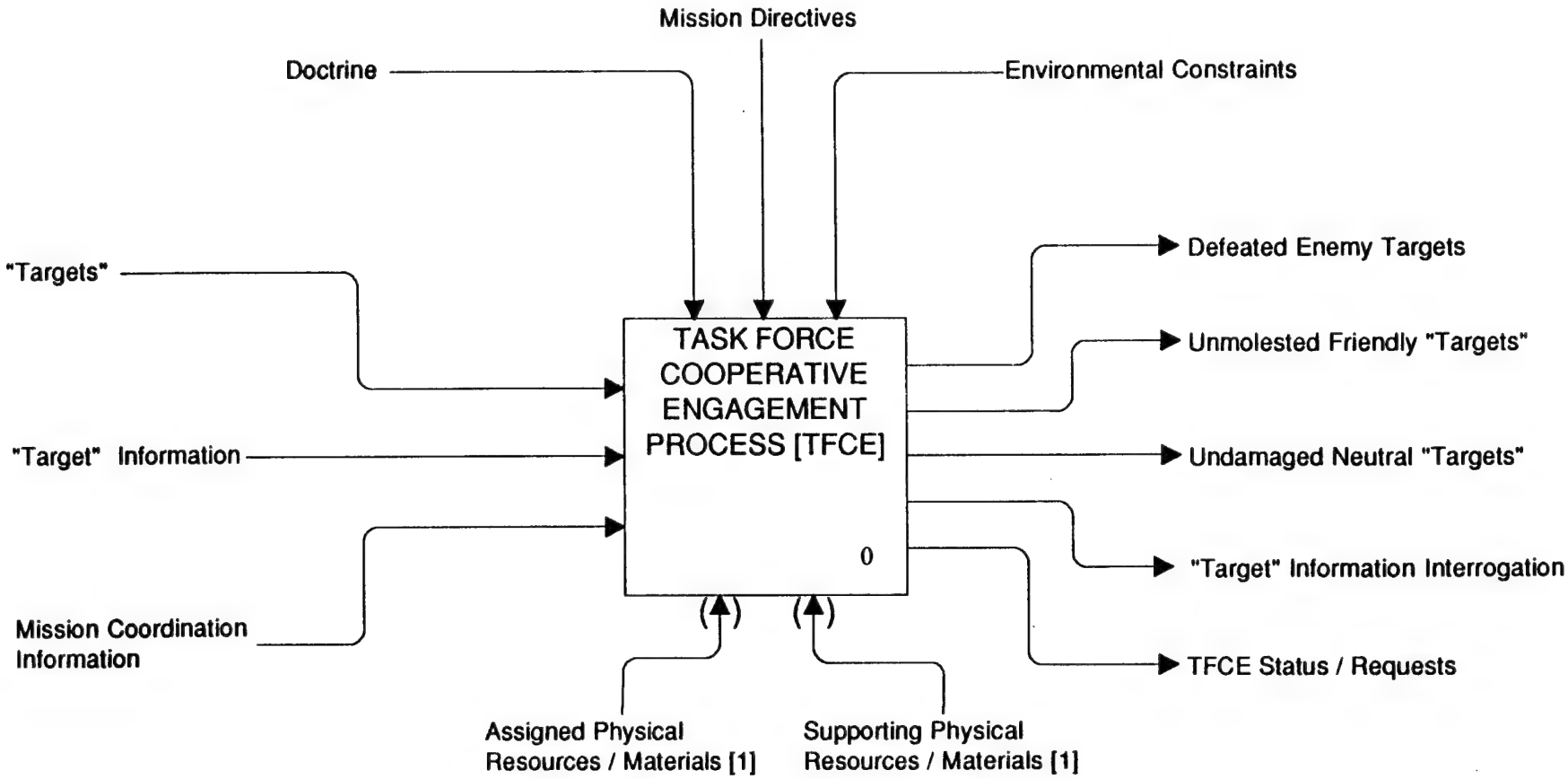
All Boxes Are Named

All Arrows are named

Done.

II. Task Force Navy Cooperative Engagement Functional Architecture Data Flow Diagrams, NCEA Mod 4.0 Full Draft-1 of 24 April 1990

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/13/90	X	WORKING	READER DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



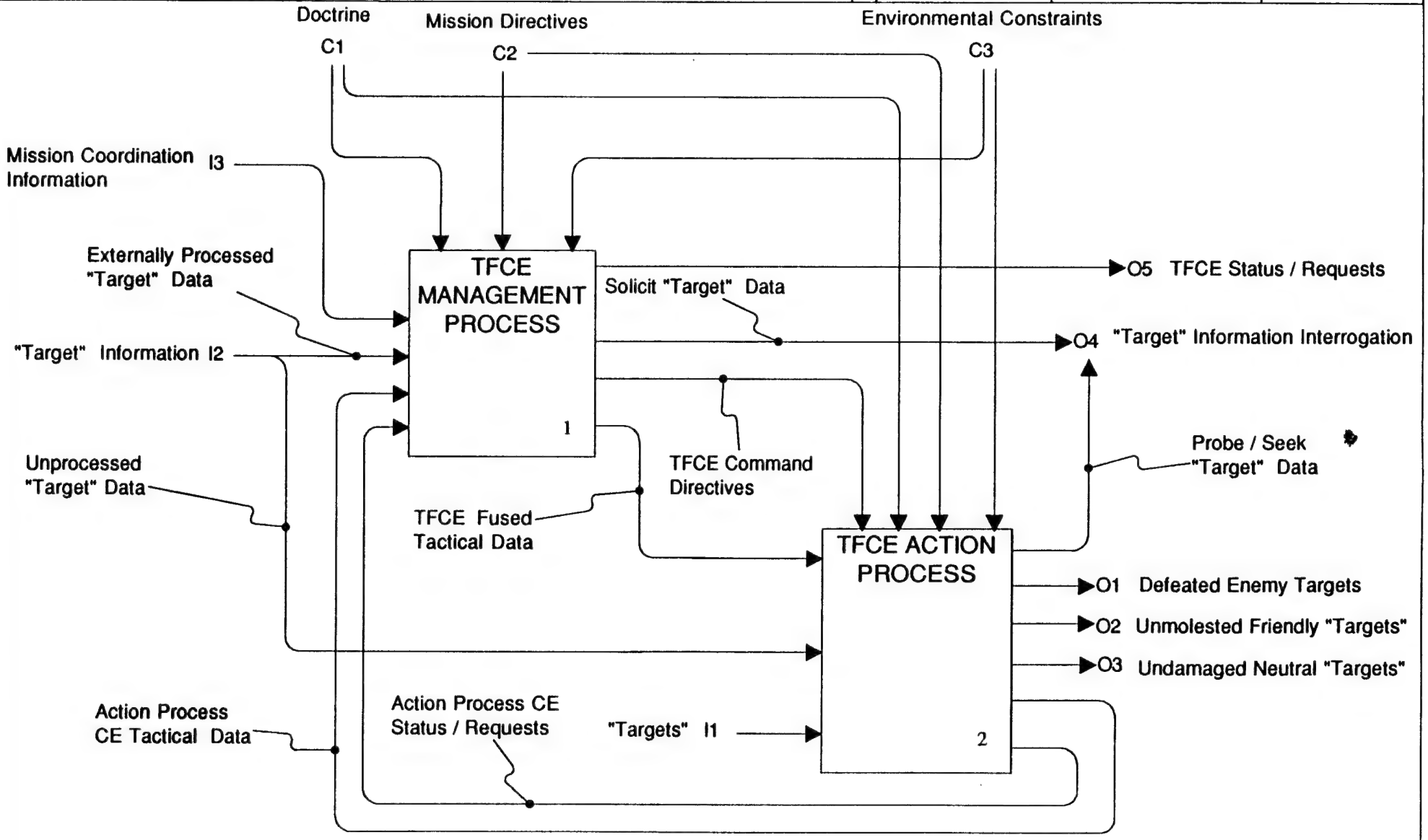
Note: [1] This feature allows the assignment of physical resource capabilities, i.e. material things, to the execution of the functional sub-processes. This mapping between the functional and physical structure of the process is omitted here for clarity. It can be added later for a given physical structure, i.e. implementation option.

Purpose: To Develop a Functional Framework for a Navy Cooperative Engagement Process

Viewpoint: The SPAWAR 31 Navy Cooperative Engagement Architecture Development Team

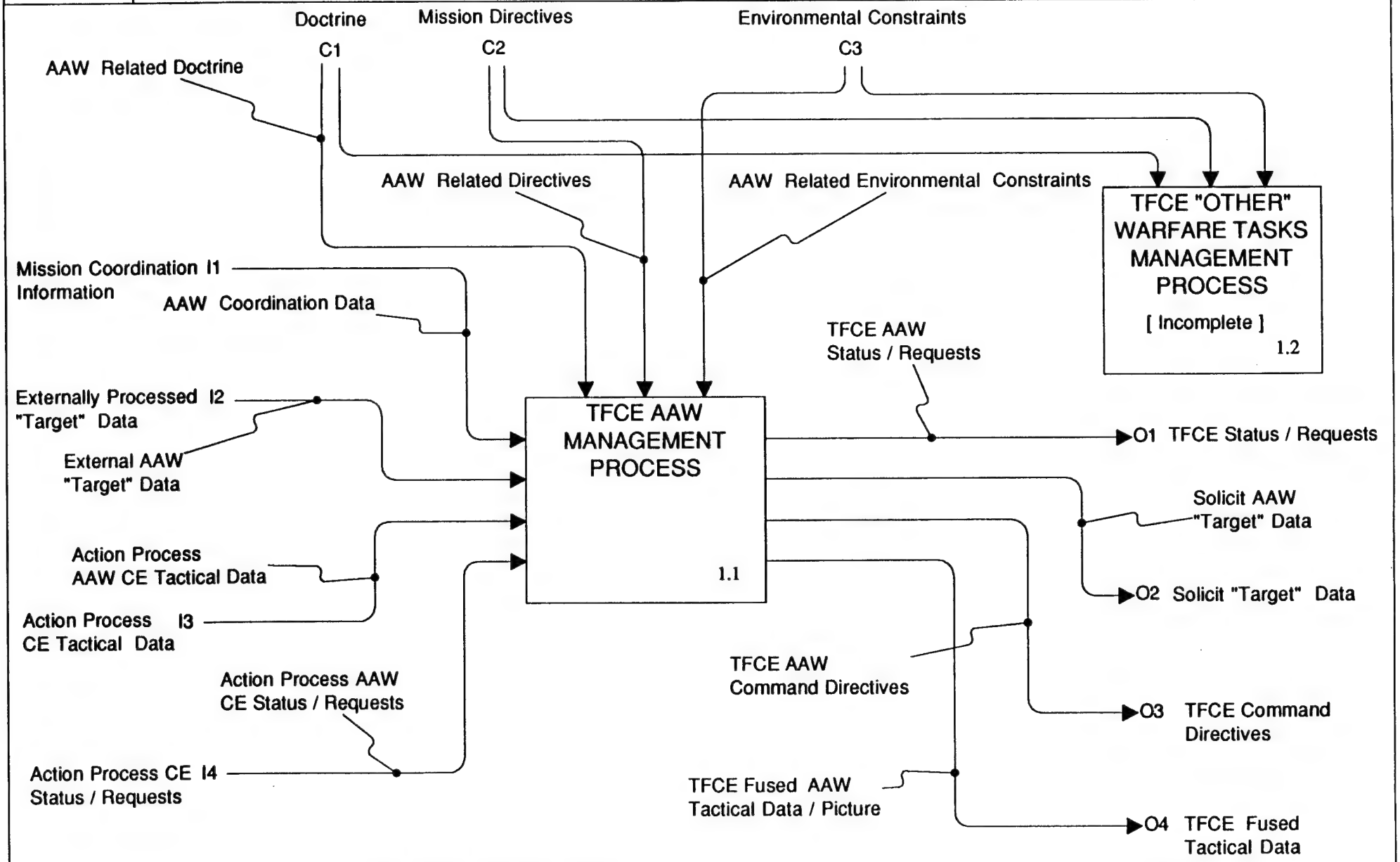
NODE: -0	TITLE: TASK FORCE COOPERATIVE ENGAGEMENT PROCESS CONTEXT DIAGRAM	NUMBER: P - 1

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/17/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



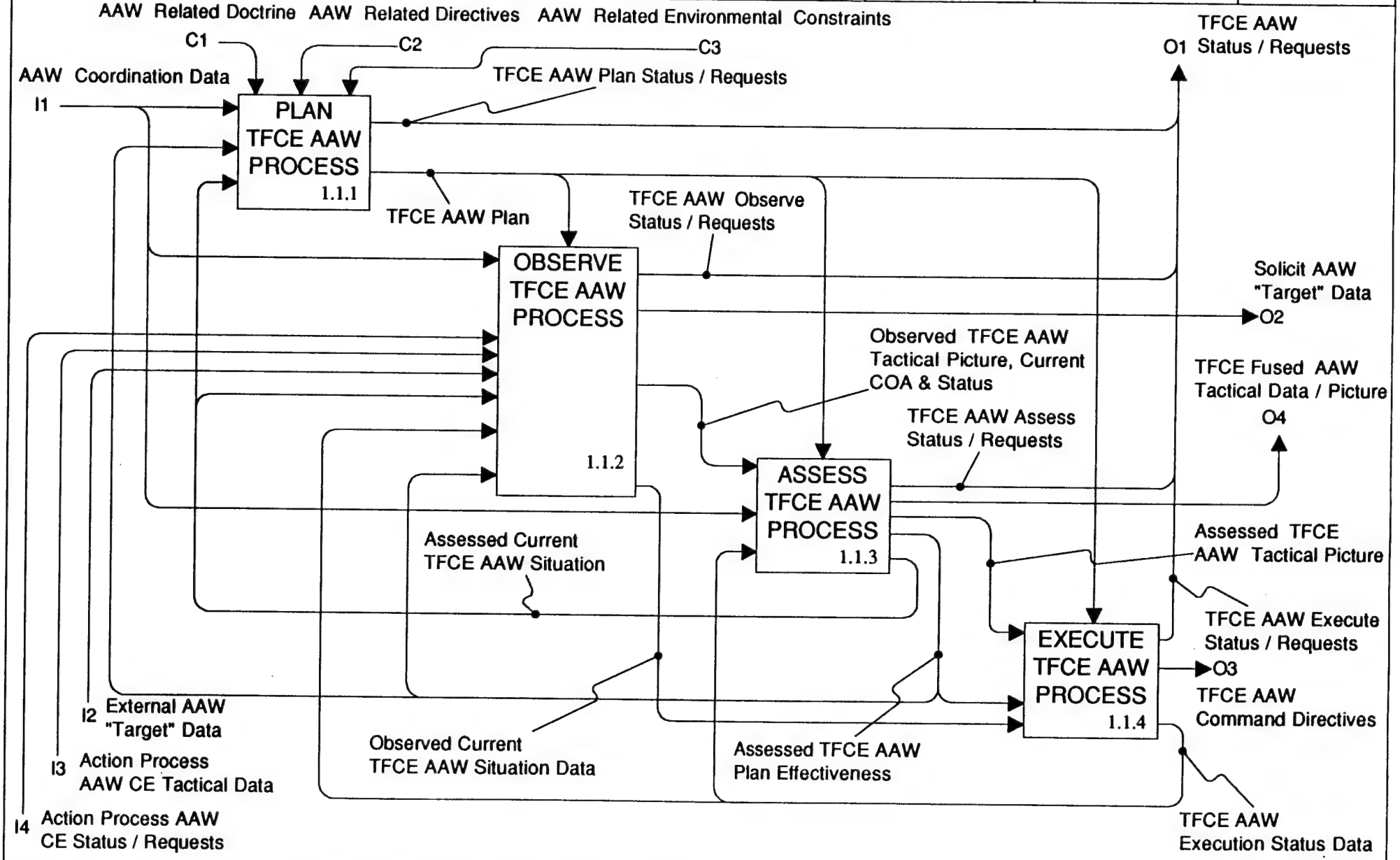
NODE: 0	TITLE: TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]	NUMBER: P-2

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/17/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



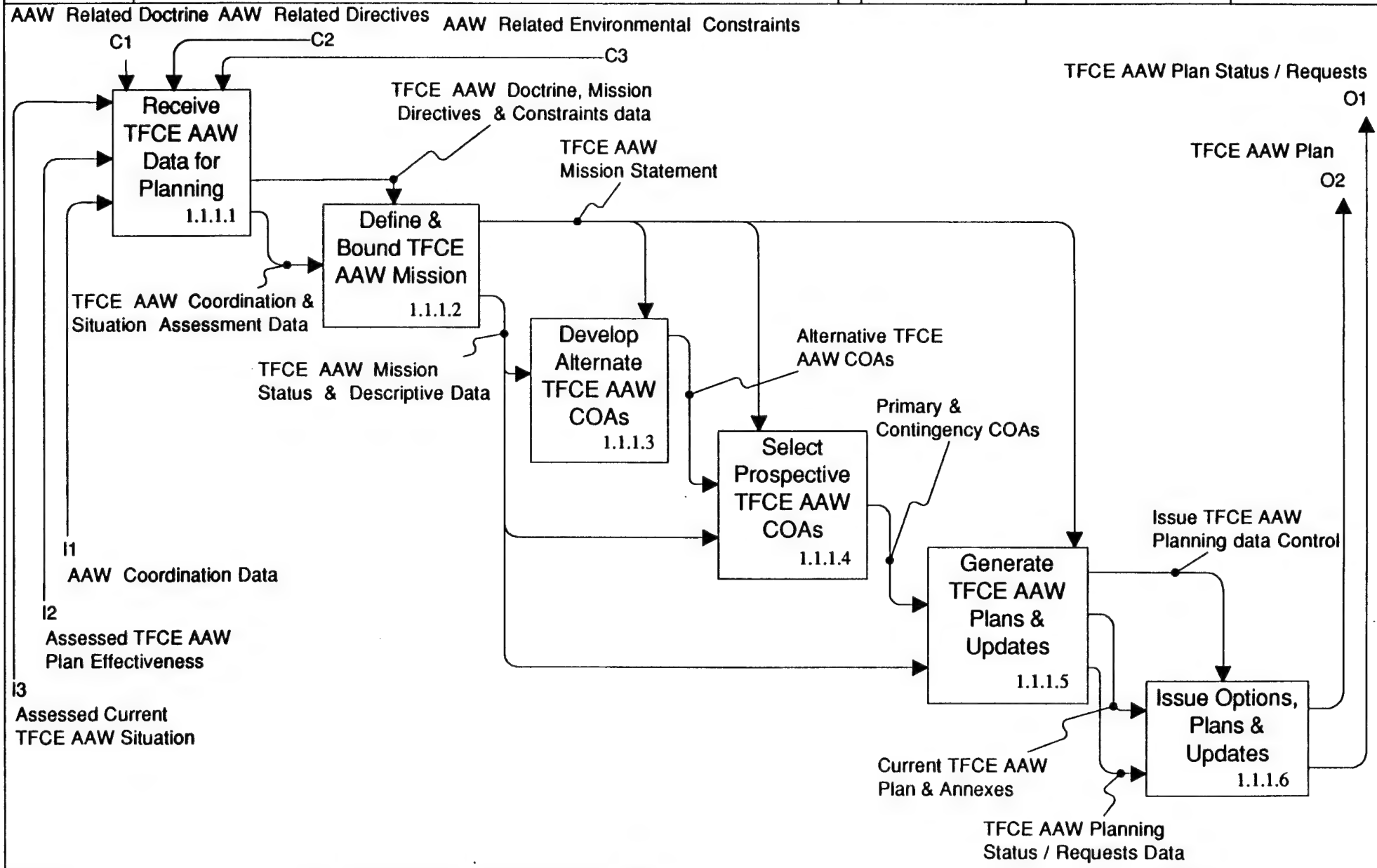
NODE: 1	TITLE: TFCE MANAGEMENT PROCESS	NUMBER: P-3

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/17/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



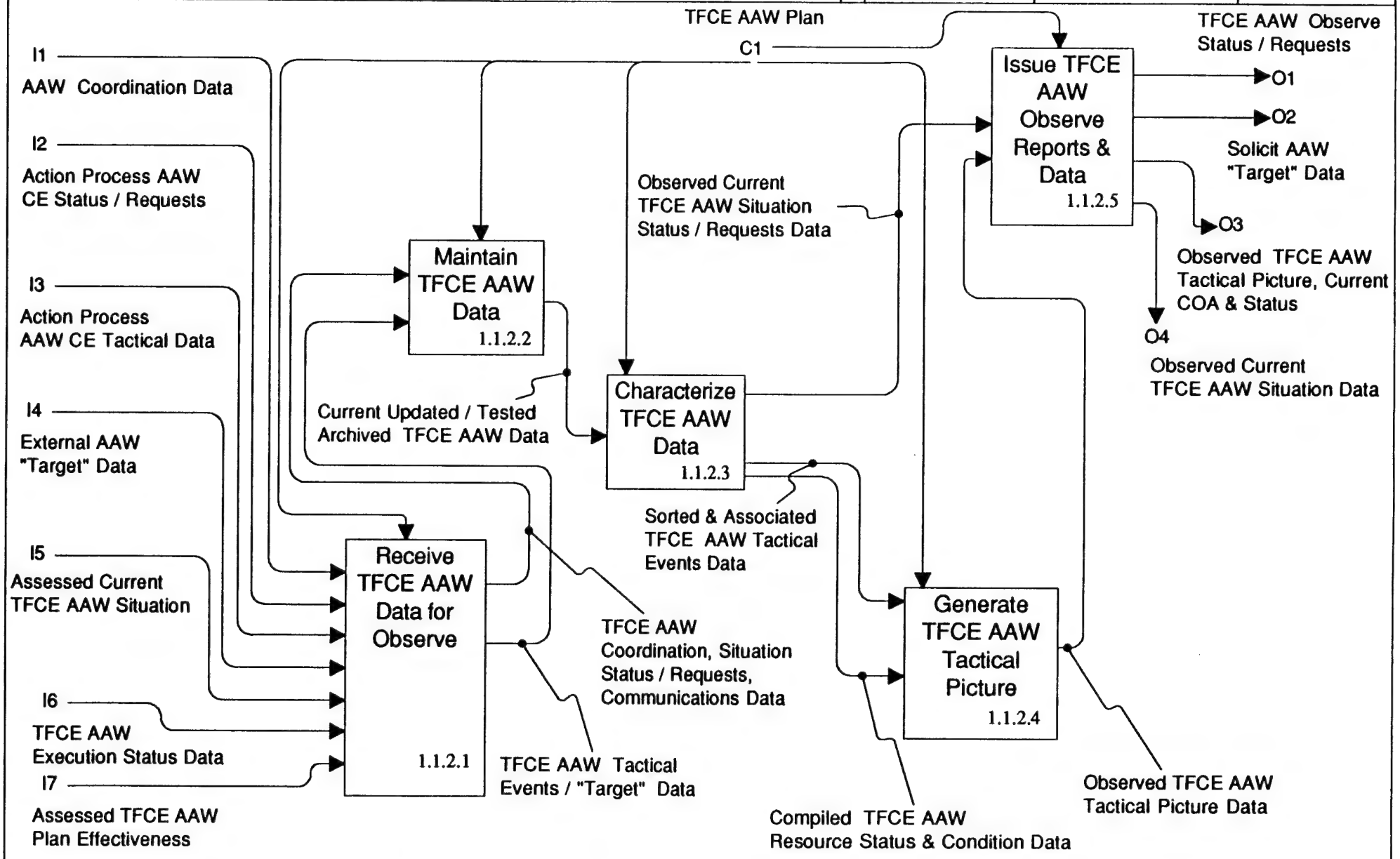
NODE: 1.1	TITLE: TFCE AAW MANAGEMENT PROCESS	NUMBER: P-4

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/18/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



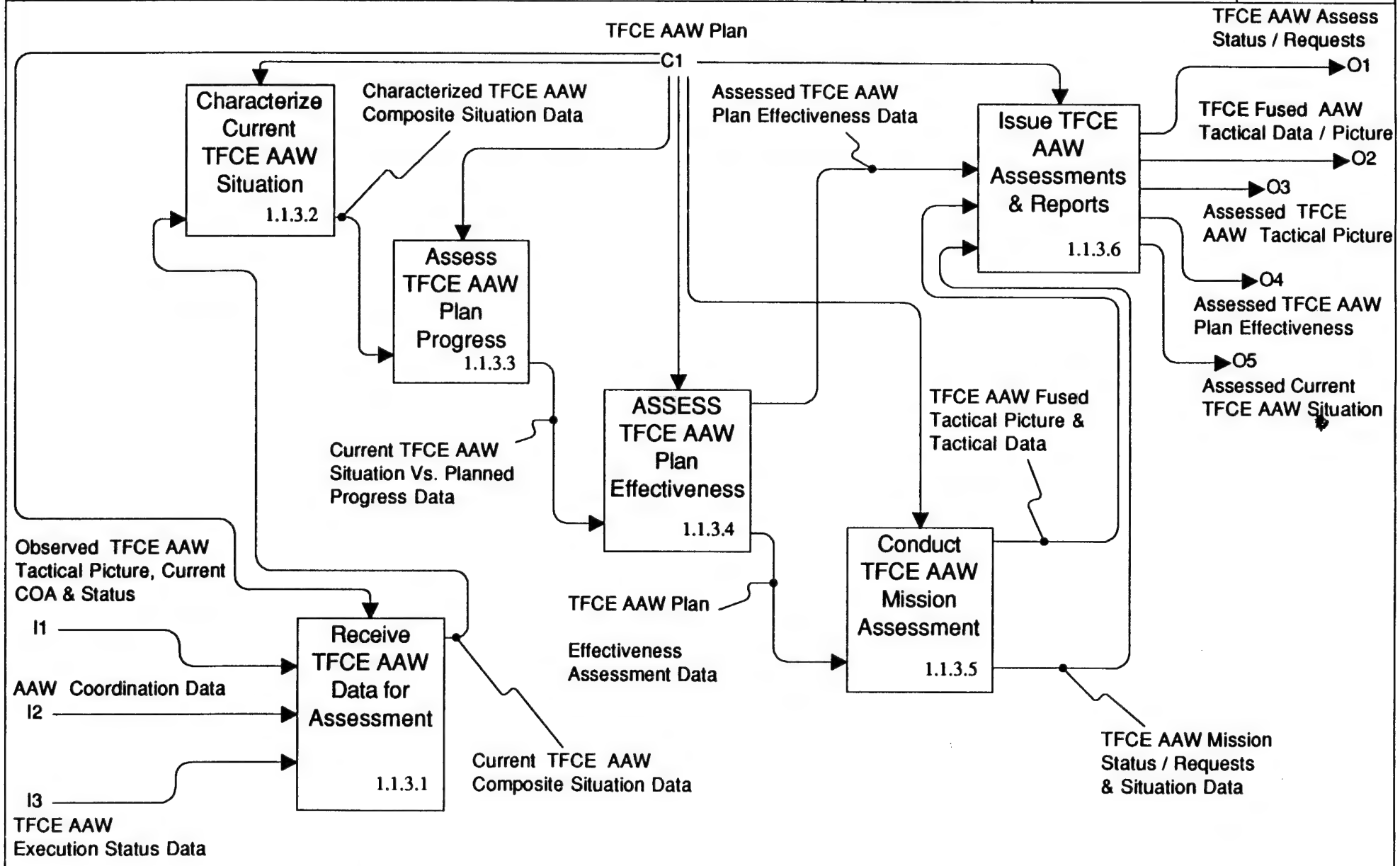
NODE: 1.1.1	TITLE: PLAN TFCE AAW PROCESS	NUMBER: P-5

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/18/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



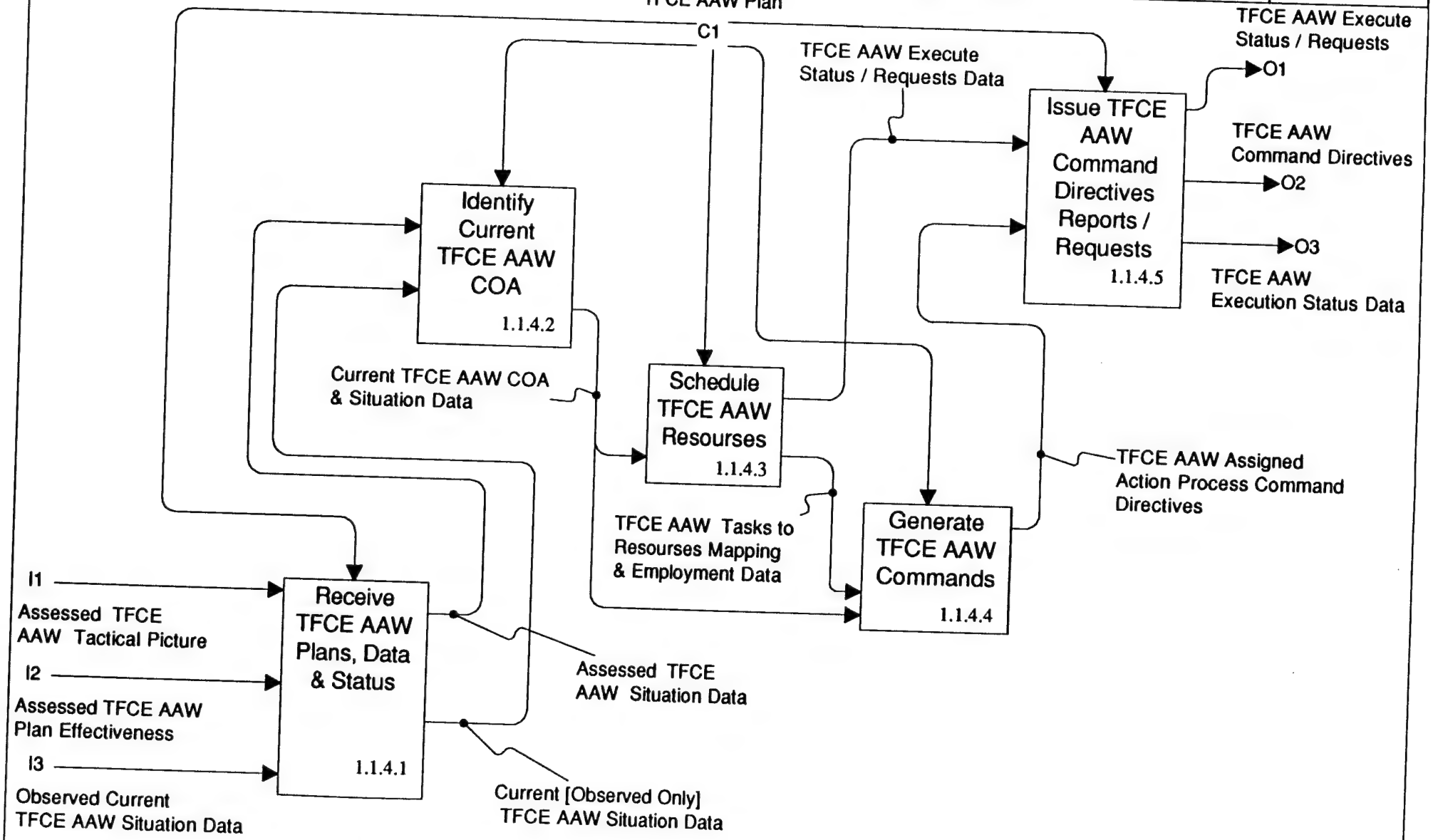
NODE: 1.1.2	TITLE: OBSERVE TFCE AAW PROCESS	NUMBER: P-6

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/18/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



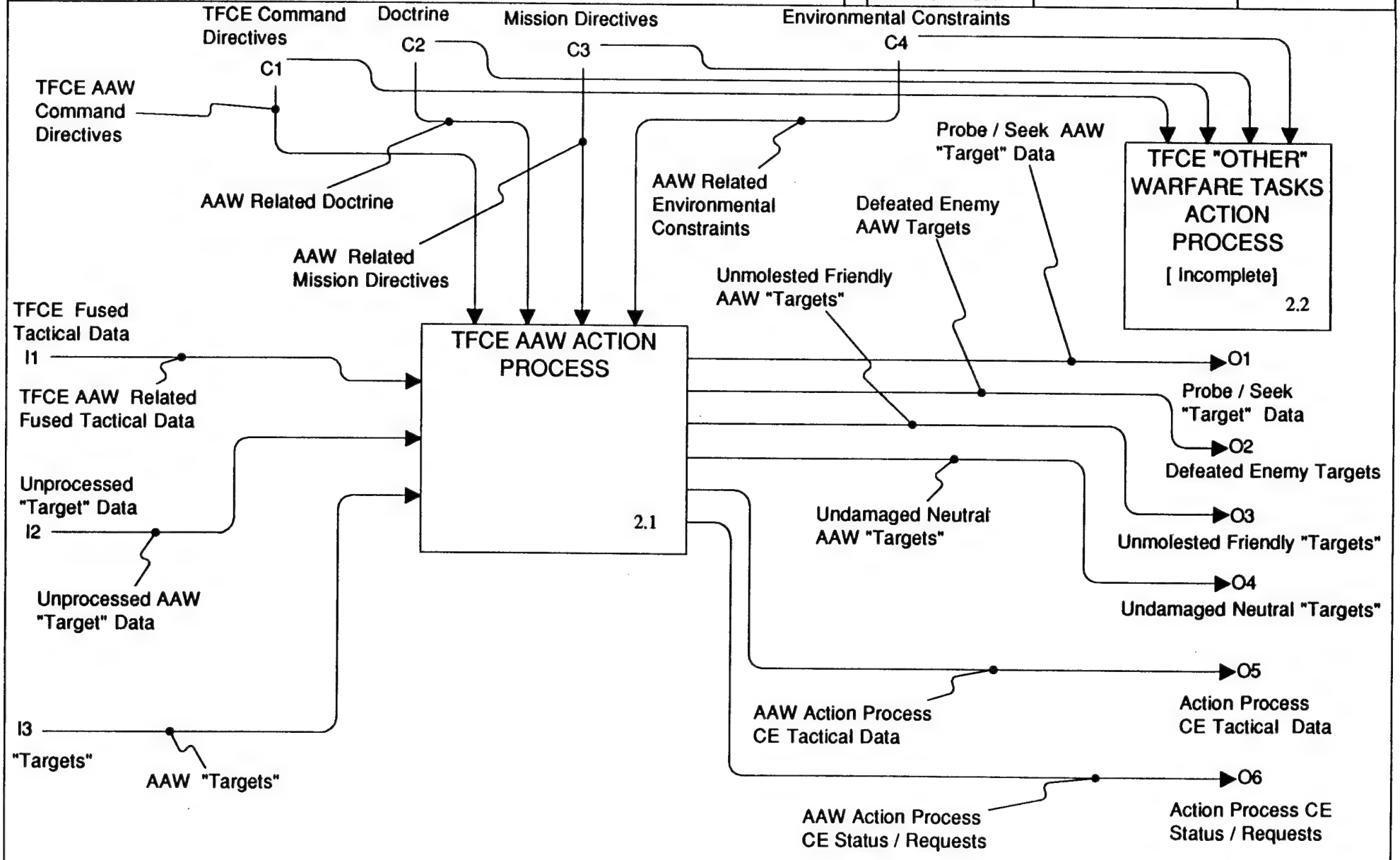
NODE: 1.1.3	TITLE: ASSESS TFCE AAW PROCESS	NUMBER: P-7

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/19/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



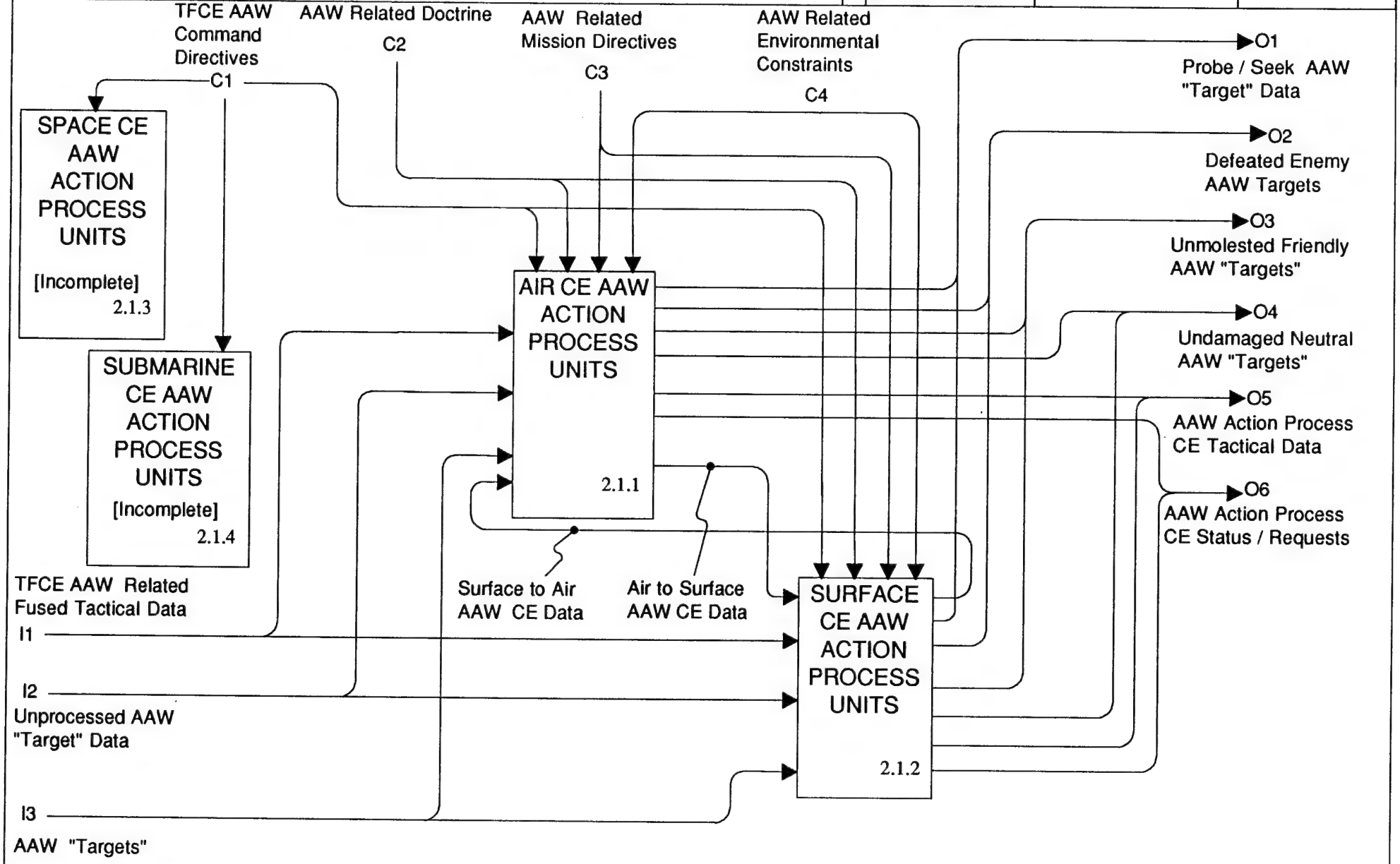
NODE: 1.1.4	TITLE: EXECUTE TFCE AAW PROCESS	NUMBER: P-8

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/19/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			☐
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			■
				PUBLICATION			



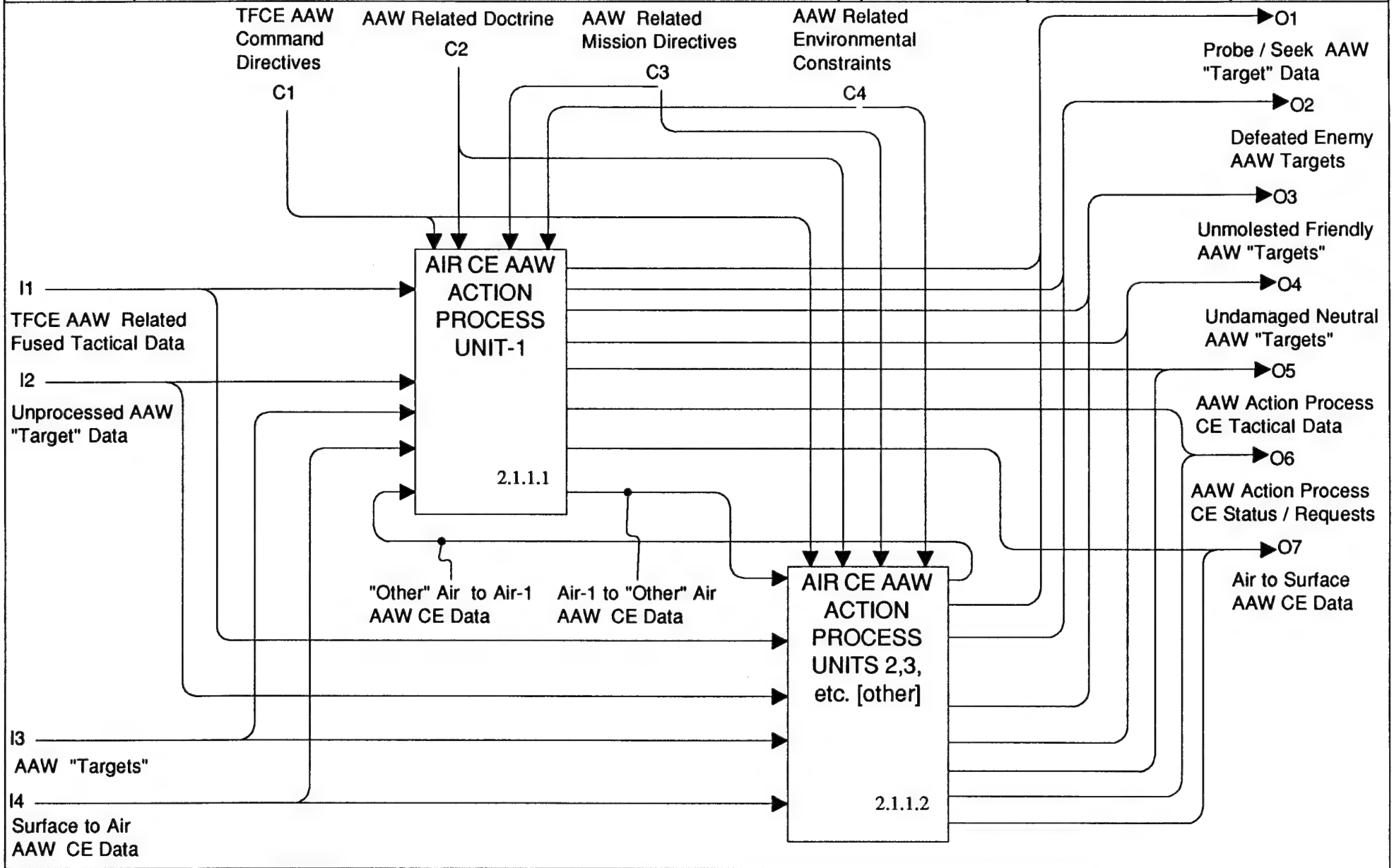
NODE: 2	TITLE: TFCE ACTION PROCESS	NUMBER: P-9

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/19/90				CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:	X	WORKING	READER DATE	
				DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



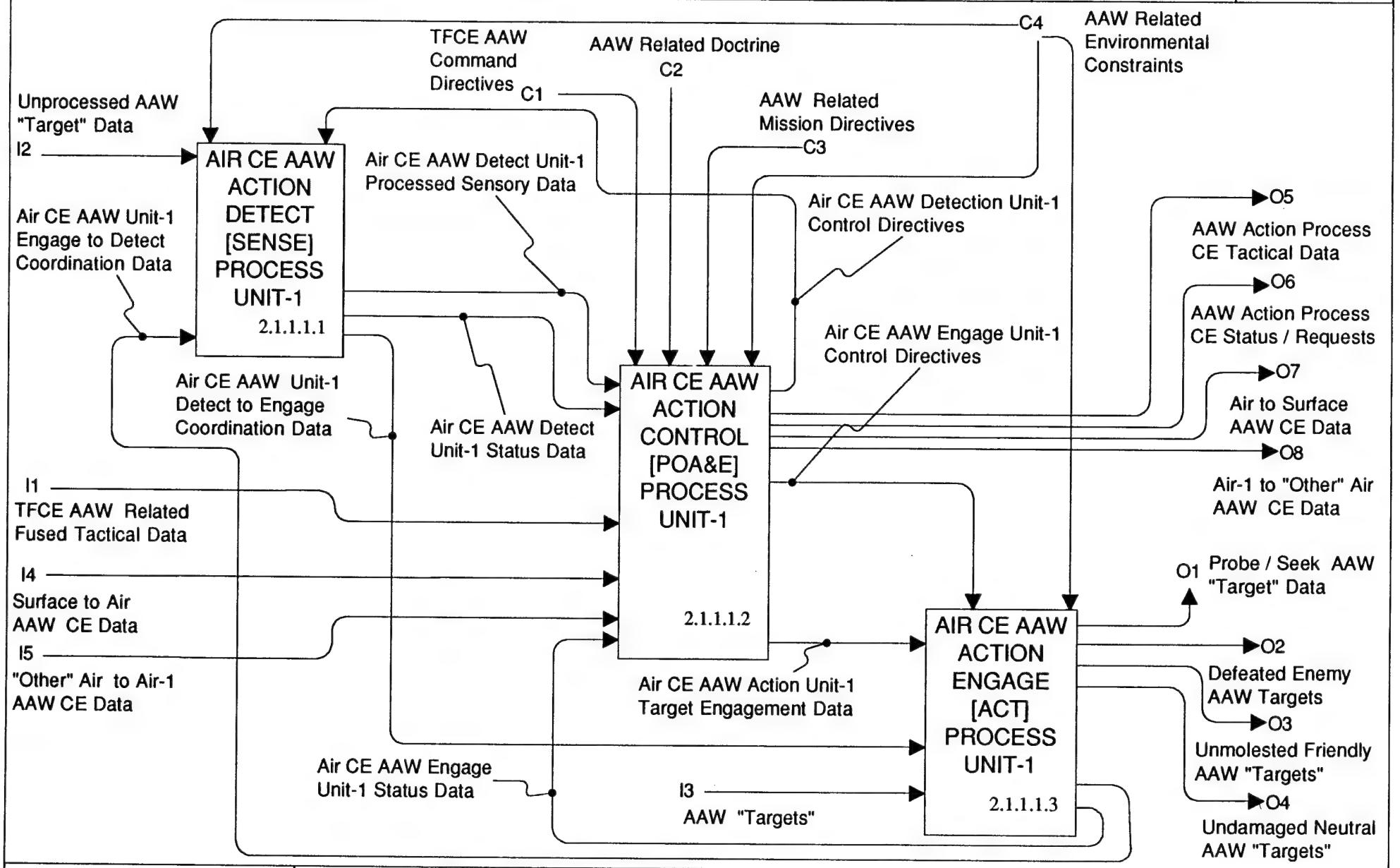
NODE: 2.1	TITLE: TFCE AAW ACTION PROCESS	NUMBER: P-10

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/19/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



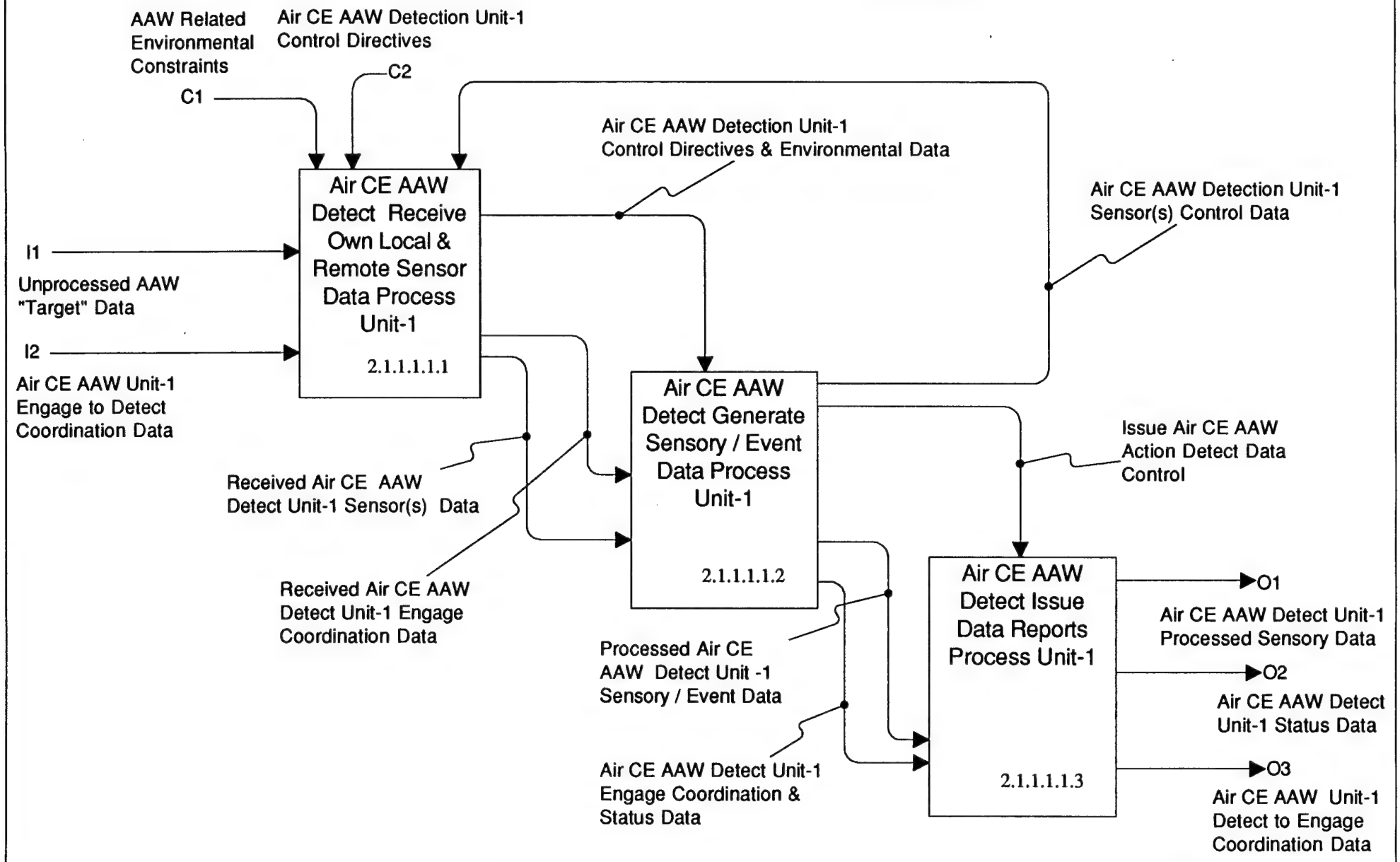
NODE: 2.1.1	TITLE: AIR CE AAW ACTION PROCESS UNITS	NUMBER: P-11

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/19/90	X	WORKING	READER DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



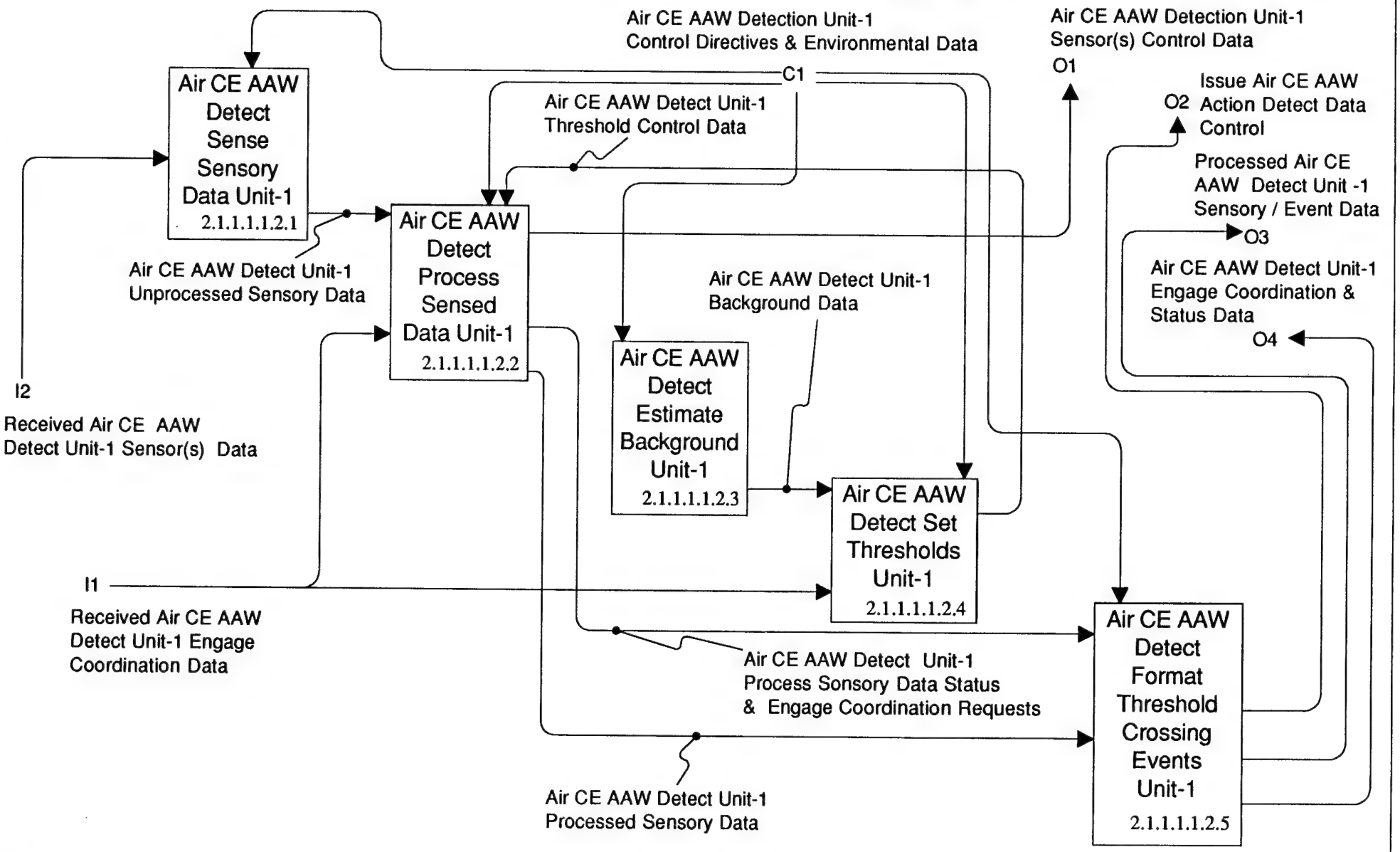
NODE: 2.1.1.1	TITLE: AIR CE AAW ACTION PROCESS UNIT-1	NUMBER: P-12

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/20/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



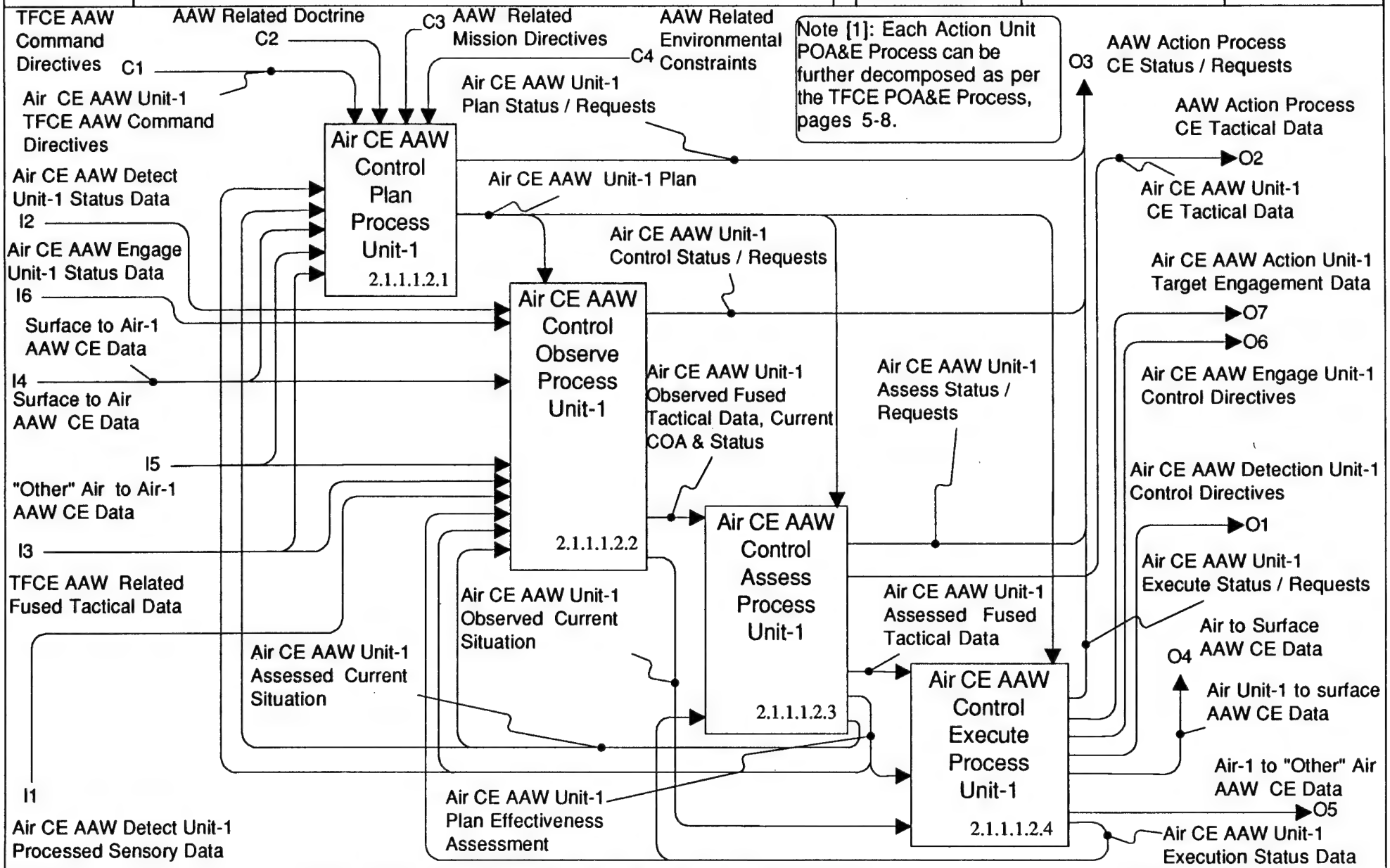
NODE: 2.1.1.1.1	TITLE: AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1	NUMBER: P-13

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/20/90	X	WORKING	READER DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



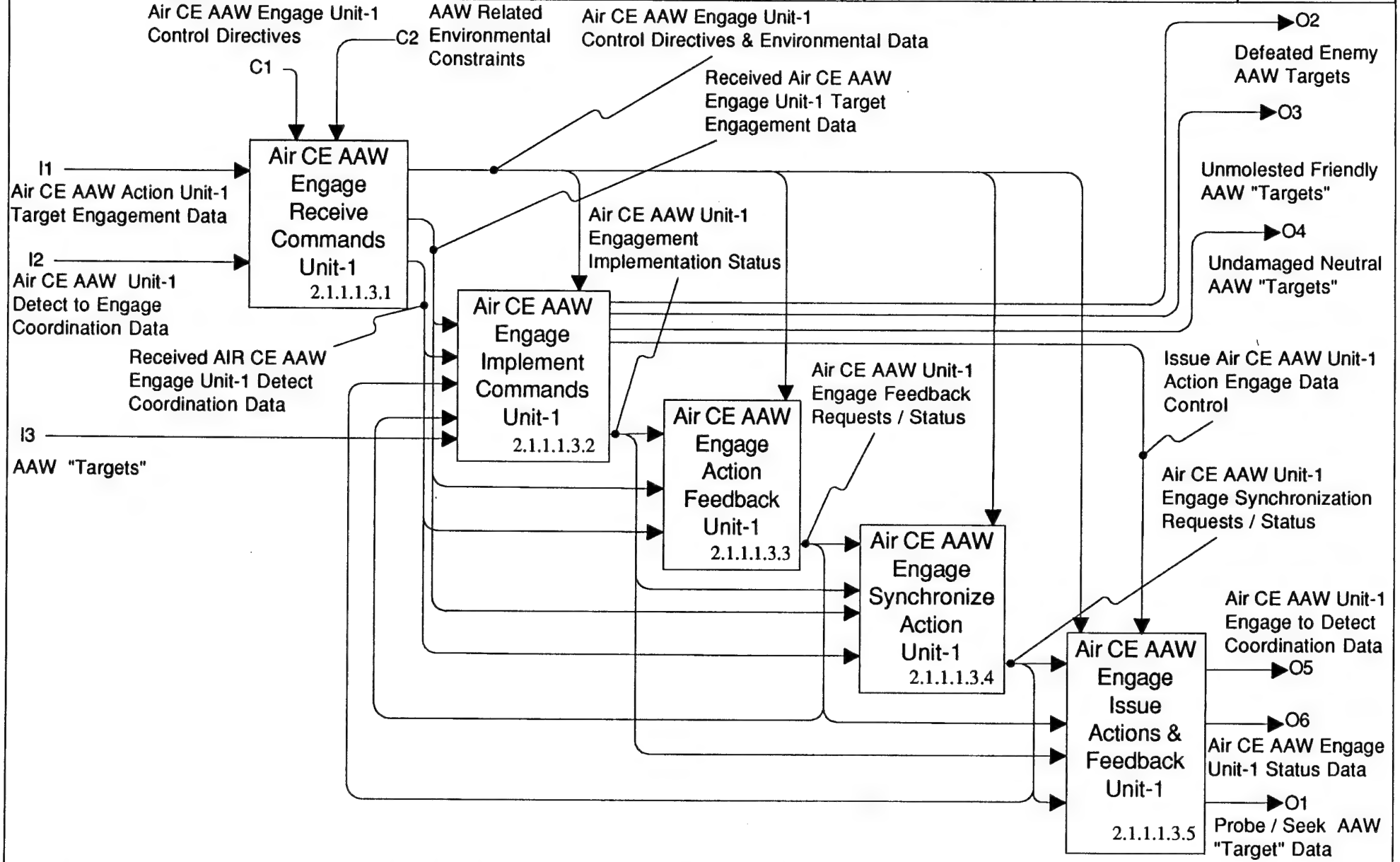
NODE: 2.1.1.1.1.2	TITLE: Air CE AAW Detect Generate Sensory / Event Data	NUMBER: P-14

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/20/90	X	WORKING	READER DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



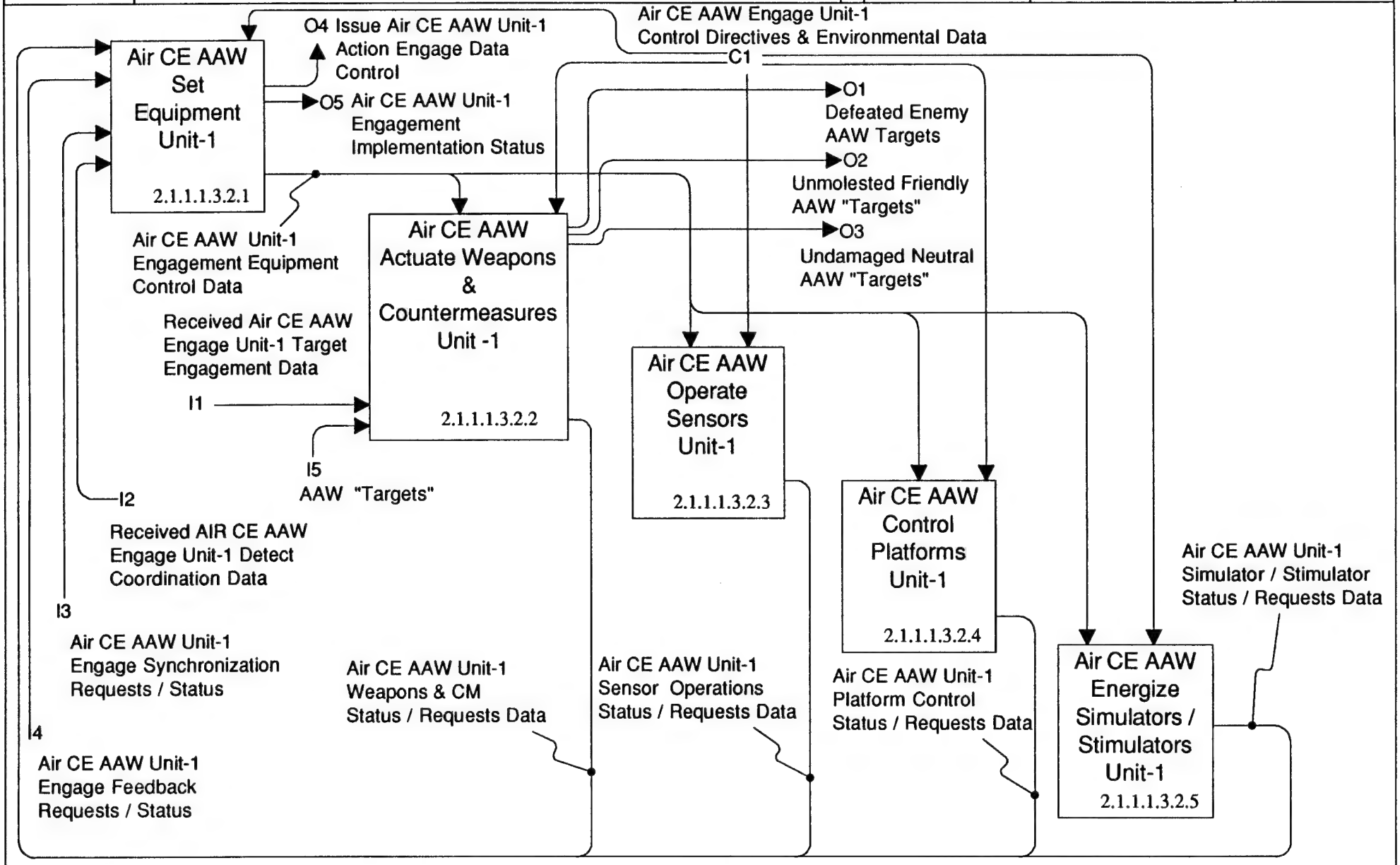
NODE: 2.1.1.1.2	TITLE: AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1	NUMBER: P-15

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/20/90	X	WORKING	READER DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT		
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED		
				PUBLICATION		



NODE: 2.1.1.1.3	TITLE: AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1	NUMBER: P-16

USED AT:	AUTHOR: Carl M. Bennett, NCSC 10T	DATE: 4/23/90	X	WORKING	READER	DATE	CONTEXT:
SPAWAR 31	PROJECT: Navy Cooperative Engagement Architecture	REV:		DRAFT			
	NOTES: 1 2 3 4 5 6 7 8 9 10			RECOMMENDED			
				PUBLICATION			



NODE: 2.1.1.1.3.2	TITLE: Air CE AAW Engage Implement Commands Unit-1	NUMBER: P-17

APPENDIX B: DESIGN/IDEF Activity Report

[0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]
- Inputs: "Targets", "Target" Information, Mission Coordination Information
- Outputs: Defeated Enemy Targets, Unmolested Friendly "Targets", Undamaged Neutral "Targets", "Target" Information Interrogation, TFCE Status / Requests
- Controls: Mission Directives, Doctrine, Environmental Constraints
- Mechanisms: Assigned Physical Resources / Materials [1], Supporting Physical Resources / Materials [1]
- Sub-Activities: [1] TFCE MANAGEMENT PROCESS, [2] TFCE ACTION PROCESS

[1] TFCE MANAGEMENT PROCESS
- Inputs: Mission Coordination Information, Externally Processed "Target" Data, Action Process CE Status / Requests, Action Process CE Tactical Data
- Outputs: TFCE Command Directives, TFCE Status / Requests, Solicit "Target" Data, TFCE Fused Tactical Data
- Controls: Environmental Constraints, Mission Directives, Doctrine
- Mechanisms: (None)
- Sub-Activities: [1.1] TFCE AAW MANAGEMENT PROCESS, [1.2] TFCE "OTHER" WARFARE TASKS MANAGEMENT PROCESS

[1.1] TFCE AAW MANAGEMENT PROCESS
- Inputs: AAW Coordination Data, External AAW "Target" Data, Action Process AAW CE Tactical Data, Action Process AAW CE Status / Requests
- Outputs: TFCE AAW Status / Requests, Solicit AAW "Target" Data, TFCE AAW Command Directives, TFCE Fused AAW Tactical Data / Picture
- Controls: AAW Related Environmental Constraints, AAW Related Directives, AAW Related Doctrine
- Mechanisms: (None)
- Sub-Activities: [1.1.1] PLAN TFCE AAW PROCESS, [1.1.2] OBSERVE TFCE AAW PROCESS, [1.1.3] ASSESS TFCE AAW PROCESS, [1.1.4] EXECUTE TFCE AAW PROCESS

[1.1.1] PLAN TFCE AAW PROCESS
- Inputs: AAW Coordination Data, Assessed TFCE AAW Plan Effectiveness, Assessed Current TFCE AAW Situation
- Outputs: TFCE AAW Plan, TFCE AAW Plan Status / Requests
- Controls: AAW Related Doctrine, AAW Related Directives, AAW Related Environmental Constraints
- Mechanisms: (None)
- Sub-Activities: [1.1.1.1] Receive TFCE AAW Data for Planning, [1.1.1.2] Define & Bound TFCE AAW Mission, [1.1.1.3] Develop Alternate TFCE AAW COAs, [1.1.1.4] Select Prospective TFCE AAW COAs, [1.1.1.5] Generate TFCE AAW Plans & Updates, [1.1.1.6] Issue Options, Plans & Updates

[1.1.1.1] Receive TFCE AAW Data for Planning

Inputs: Assessed Current TFCE AAW Situation, Assessed TFCE AAW Plan Effectiveness, AAW Coordination Data
Outputs: TFCE AAW Doctrine, Mission Directives & Constraints data, TFCE AAW Coordination & Situation Assessment Data
Controls: AAW Related Doctrine, AAW Related Directives, AAW Related Environmental Constraints
Mechanisms: (None)

[1.1.1.2] Define & Bound TFCE AAW Mission
Inputs: TFCE AAW Coordination & Situation Assessment Data
Outputs: TFCE AAW Mission Statement, TFCE AAW Mission Status & Descriptive Data
Controls: TFCE AAW Doctrine, Mission Directives & Constraints data
Mechanisms: (None)

[1.1.1.3] Develop Alternate TFCE AAW COAs
Inputs: TFCE AAW Mission Status & Descriptive Data
Outputs: Alternative TFCE AAW COAs
Controls: TFCE AAW Mission Statement
Mechanisms: (None)

[1.1.1.4] Select Prospective TFCE AAW COAs
Inputs: TFCE AAW Mission Status & Descriptive Data, Alternative TFCE AAW COAs
Outputs: Primary & Contingency COAs
Controls: TFCE AAW Mission Statement
Mechanisms: (None)

[1.1.1.5] Generate TFCE AAW Plans & Updates
Inputs: Primary & Contingency COAs, TFCE AAW Mission Status & Descriptive Data
Outputs: Current TFCE AAW Plan & Annexes, Issue TFCE AAW Planning data Control, TFCE AAW Planning Status / Requests Data
Controls: TFCE AAW Mission Statement
Mechanisms: (None)

[1.1.1.6] Issue Options, Plans & Updates
Inputs: Current TFCE AAW Plan & Annexes, TFCE AAW Planning Status / Requests Data
Outputs: TFCE AAW Plan Status / Requests, TFCE AAW Plan
Controls: Issue TFCE AAW Planning data Control
Mechanisms: (None)

[1.1.2] OBSERVE TFCE AAW PROCESS
Inputs: External AAW "Target" Data, Action Process AAW CE Tactical Data, Action Process AAW CE Status / Requests, AAW Coordination Data, Assessed TFCE AAW Plan Effectiveness, Assessed Current TFCE AAW Situation, TFCE AAW Execution Status Data

Outputs: TFCE AAW Observe Status / Requests, Solicit AAW "Target" Data, Observed Current TFCE AAW Situation Data, Observed TFCE AAW Tactical Picture, Current COA & Status
Controls: TFCE AAW Plan
Mechanisms: (None)
Sub-Activities: [1.1.2.1] Receive TFCE AAW Data for Observe, [1.1.2.2] Maintain TFCE AAW Data, [1.1.2.3] Characterize TFCE AAW Data, [1.1.2.4] Generate TFCE AAW Tactical Picture, [1.1.2.5] Issue TFCE AAW Observe Reports & Data

[1.1.2.1] Receive TFCE AAW Data for Observe
Inputs: Assessed TFCE AAW Plan Effectiveness, TFCE AAW Execution Status Data, Assessed Current TFCE AAW Situation, External AAW "Target" Data, Action Process AAW CE Tactical Data, Action Process AAW CE Status / Requests, AAW Coordination Data
Outputs: TFCE AAW Coordination, Situation Status / Requests, Communications Data, TFCE AAW Tactical Events / "Target" Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.2.2] Maintain TFCE AAW Data
Inputs: TFCE AAW Coordination, Situation Status / Requests, Communications Data, TFCE AAW Tactical Events / "Target" Data
Outputs: Current Updated / Tested Archived TFCE AAW Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.2.3] Characterize TFCE AAW Data
Inputs: Current Updated / Tested Archived TFCE AAW Data
Outputs: Sorted & Associated TFCE AAW Tactical Events Data, Compiled TFCE AAW Resource Status & Condition Data, Observed Current TFCE AAW Situation Status / Requests Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.2.4] Generate TFCE AAW Tactical Picture
Inputs: Sorted & Associated TFCE AAW Tactical Events Data, Compiled TFCE AAW Resource Status & Condition Data
Outputs: Observed TFCE AAW Tactical Picture Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.2.5] Issue TFCE AAW Observe Reports & Data
Inputs: Observed TFCE AAW Tactical Picture Data, Observed Current TFCE AAW Situation Status / Requests Data
Outputs: TFCE AAW Observe Status / Requests, Solicit AAW "Target" Data, Observed TFCE AAW

Tactical Picture, Current COA & Status, Observed Current TFCE AAW Situation Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.3] ASSESS TFCE AAW PROCESS
Inputs: Observed TFCE AAW Tactical Picture, Current COA & Status, AAW Coordination Data, TFCE AAW Execution Status Data
Outputs: TFCE AAW Assess Status / Requests, TFCE Fused AAW Tactical Data / Picture, Assessed TFCE AAW Tactical Picture, Assessed TFCE AAW Plan Effectiveness, Assessed Current TFCE AAW Situation
Controls: TFCE AAW Plan
Mechanisms: (None)
Sub-Activities: [1.1.3.1] Receive TFCE AAW Data for Assessment, [1.1.3.2] Characterize Current TFCE AAW Situation, [1.1.3.3] Assess TFCE AAW Plan Progress, [1.1.3.4] ASSESS TFCE AAW Plan Effectiveness, [1.1.3.5] Conduct TFCE AAW Mission Assessment , [1.1.3.6] Issue TFCE AAW Assessments & Reports

[1.1.3.1] Receive TFCE AAW Data for Assessment
Inputs: Observed TFCE AAW Tactical Picture, Current COA & Status, AAW Coordination Data, TFCE AAW Execution Status Data
Outputs: Current TFCE AAW Composite Situation Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.3.2] Characterize Current TFCE AAW Situation
Inputs: Current TFCE AAW Composite Situation Data
Outputs: Characterized TFCE AAW Composite Situation Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.3.3] Assess TFCE AAW Plan Progress
Inputs: Characterized TFCE AAW Composite Situation Data
Outputs: Current TFCE AAW Situation Vs. Planned Progress Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.3.4] ASSESS TFCE AAW Plan Effectiveness
Inputs: Current TFCE AAW Situation Vs. Planned Progress Data
Outputs: TFCE AAW Plan Effectiveness Assessment Data, Assessed TFCE AAW Plan Effectiveness Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.3.5] Conduct TFCE AAW Mission Assessment
Inputs: TFCE AAW Plan Effectiveness Assessment Data
Outputs: TFCE AAW Mission Status / Requests & Situation Data, TFCE AAW Fused Tactical Picture & Tactical Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.3.6] Issue TFCE AAW Assessments & Reports
Inputs: Assessed TFCE AAW Plan Effectiveness Data, TFCE AAW Mission Status / Requests & Situation Data, TFCE AAW Fused Tactical Picture & Tactical Data
Outputs: TFCE AAW Assess Status / Requests, TFCE Fused AAW Tactical Data / Picture, Assessed TFCE AAW Tactical Picture, Assessed TFCE AAW Plan Effectiveness, Assessed Current TFCE AAW Situation
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.4] EXECUTE TFCE AAW PROCESS
Inputs: Observed Current TFCE AAW Situation Data, Assessed TFCE AAW Tactical Picture, Assessed TFCE AAW Plan Effectiveness
Outputs: TFCE AAW Command Directives, TFCE AAW Execute Status / Requests, TFCE AAW Execution Status Data
Controls: TFCE AAW Plan
Mechanisms: (None)
Sub-Activities: [1.1.4.1] Receive TFCE AAW Plans, Data & Status, [1.1.4.2] Identify Current TFCE AAW COA, [1.1.4.3] Schedule TFCE AAW Resourses, [1.1.4.4] Generate TFCE AAW Commands, [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests

[1.1.4.1] Receive TFCE AAW Plans, Data & Status
Inputs: Assessed TFCE AAW Tactical Picture, Assessed TFCE AAW Plan Effectiveness, Observed Current TFCE AAW Situation Data
Outputs: Current [Observed Only] TFCE AAW Situation Data, Assessed TFCE AAW Situation Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.4.2] Identify Current TFCE AAW COA
Inputs: Current [Observed Only] TFCE AAW Situation Data, Assessed TFCE AAW Situation Data
Outputs: Current TFCE AAW COA & Situation Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.4.3] Schedule TFCE AAW Resourses
Inputs: Current TFCE AAW COA & Situation Data

Outputs: TFCE AAW Tasks to Resourses Mapping & Employment Data, TFCE AAW Execute Status / Requests Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.4.4] Generate TFCE AAW Commands
Inputs: TFCE AAW Tasks to Resourses Mapping & Employment Data, Current TFCE AAW COA & Situation Data
Outputs: TFCE AAW Assigned Action Process Command Directives
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests
Inputs: TFCE AAW Assigned Action Process Command Directives, TFCE AAW Execute Status / Requests Data
Outputs: TFCE AAW Execute Status / Requests, TFCE AAW Command Directives, TFCE AAW Execution Status Data
Controls: TFCE AAW Plan
Mechanisms: (None)

[1.2] TFCE "OTHER" WARFARE TASKS MANAGEMENT PROCESS
Inputs: (None)
Outputs: (None)
Controls: Environmental Constraints, Mission Directives, Doctrine
Mechanisms: (None)

[2] TFCE ACTION PROCESS
Inputs: "Targets", Unprocessed "Target" Data, TFCE Fused Tactical Data
Outputs: Defeated Enemy Targets, Unmolested Friendly "Targets", Undamaged Neutral "Targets", Probe / Seek "Target" Data, Action Process CE Status / Requests, Action Process CE Tactical Data
Controls: TFCE Command Directives, Environmental Constraints, Mission Directives, Doctrine
Mechanisms: (None)
Sub-Activities: [2.1] TFCE AAW ACTION PROCESS, [2.2] TFCE "OTHER" WARFARE TASKS ACTION PROCESS

[2.1] TFCE AAW ACTION PROCESS
Inputs: TFCE AAW Related Fused Tactical Data, Unprocessed AAW "Target" Data, AAW "Targets"
Outputs: Probe / Seek AAW "Target" Data, Defeated Enemy AAW Targets, Unmolested Friendly AAW "Targets", Undamaged Neutral AAW "Targets", AAW Action Process CE Tactical Data, AAW Action Process CE Status / Requests
Controls: AAW Related Environmental Constraints, AAW Related Mission Directives, AAW Related Doctrine, TFCE AAW Command Directives
Mechanisms: (None)

Sub-Activities: [2.1.1] AIR CE AAW ACTION PROCESS UNITS, [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS, [2.1.3] SPACE CE AAW ACTION PROCESS UNITS, [2.1.4] SUBMARINE CE AAW ACTION PROCESS UNITS

[2.1.1] AIR CE AAW ACTION PROCESS UNITS
- Inputs: AAW "Targets", Unprocessed AAW "Target" Data, TFCE AAW Related Fused Tactical Data, Surface to Air AAW CE Data
- Outputs: Air to Surface AAW CE Data, Probe / Seek AAW "Target" Data, Defeated Enemy AAW Targets, Unmolested Friendly AAW "Targets", Undamaged Neutral AAW "Targets", AAW Action Process CE Tactical Data, AAW Action Process CE Status / Requests
- Controls: TFCE AAW Command Directives, AAW Related Doctrine, AAW Related Mission Directives, AAW Related Environmental Constraints
- Mechanisms: (None)
- Sub-Activities: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1, [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

[2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
- Inputs: "Other" Air to Air-1 AAW CE Data, TFCE AAW Related Fused Tactical Data, Unprocessed AAW "Target" Data, AAW "Targets", Surface to Air AAW CE Data
- Outputs: Air-1 to "Other" Air AAW CE Data, Probe / Seek AAW "Target" Data, Defeated Enemy AAW Targets, Unmolested Friendly AAW "Targets", Undamaged Neutral AAW "Targets", AAW Action Process CE Tactical Data, AAW Action Process CE Status / Requests, Air to Surface AAW CE Data
- Controls: TFCE AAW Command Directives, AAW Related Doctrine, AAW Related Mission Directives, AAW Related Environmental Constraints
- Mechanisms: (None)
- Sub-Activities: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1 , [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1 , [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

[2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1
- Inputs: Unprocessed AAW "Target" Data, Air CE AAW Unit-1 Engage to Detect Coordination Data
- Outputs: Air CE AAW Detect Unit-1 Processed Sensory Data, Air CE AAW Detect Unit-1 Status Data, Air CE AAW Unit-1 Detect to Engage Coordination Data
- Controls: AAW Related Environmental Constraints, Air CE AAW Detection Unit-1 Control Directives

Mechanisms: (None)
Sub-Activities: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc, [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1, [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1

[2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc
Inputs: Air CE AAW Unit-1 Engage to Detect Coordination Data, Unprocessed AAW "Target" Data
Outputs: Received Air CE AAW Detect Unit-1 Sensor(s) Data, Air CE AAW Detection Unit-1 Control Directives & Environmental Data, Received Air CE AAW Detect Unit-1 Engage Coordination Data
Controls: AAW Related Environmental Constraints, Air CE AAW Detection Unit-1 Control Directives, Air CE AAW Detection Unit-1 Sensor(s) Control Data
Mechanisms: (None)

[2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1
Inputs: Received Air CE AAW Detect Unit-1 Sensor(s) Data, Received Air CE AAW Detect Unit-1 Engage Coordination Data
Outputs: Issue Air CE AAW Action Detect Data Control, Processed Air CE AAW Detect Unit -1 Sensory / Event Data , Air CE AAW Detect Unit-1 Engage Coordination & Status Data, Air CE AAW Detection Unit-1 Sensor(s) Control Data
Controls: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Mechanisms: (None)
Sub-Activities: [2.1.1.1.1.2.1] Air CE AAW Detect Sense Sensory Data Unit-1, [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1, [2.1.1.1.1.2.3] Air CE AAW Detect Estimate Background Unit-1, [2.1.1.1.1.2.4] Air CE AAW Detect Set Thresholds Unit-1, [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1

[2.1.1.1.1.2.1] Air CE AAW Detect Sense Sensory Data Unit-1
Inputs: Received Air CE AAW Detect Unit-1 Sensor(s) Data

Outputs: Air CE AAW Detect Unit-1 Unprocessed Sensory Data
Controls: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1
Inputs: Air CE AAW Detect Unit-1 Unprocessed Sensory Data, Received Air CE AAW Detect Unit-1 Engage Coordination Data
Outputs: Air CE AAW Detect Unit-1 Processed Sensory Data, Air CE AAW Detection Unit-1 Sensor(s) Control Data, Air CE AAW Detect Unit-1 Process Sonsory Data Status & Engage Coordination Requests
Controls: Air CE AAW Detection Unit-1 Control Directives & Environmental Data, Air CE AAW Detect Unit-1 Threshold Control Data
Mechanisms: (None)

[2.1.1.1.1.2.3] Air CE AAW Detect Estimate Background Unit-1
Inputs: (None)
Outputs: Air CE AAW Detect Unit-1 Background Data
Controls: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.1.2.4] Air CE AAW Detect Set Thresholds Unit-1
Inputs: Air CE AAW Detect Unit-1 Background Data, Received Air CE AAW Detect Unit-1 Engage Coordination Data
Outputs: Air CE AAW Detect Unit-1 Threshold Control Data
Controls: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1
Inputs: Air CE AAW Detect Unit-1 Processed Sensory Data, Air CE AAW Detect Unit-1 Process Sonsory Data Status & Engage Coordination Requests
Outputs: Issue Air CE AAW Action

Detect Data Control, Processed Air CE AAW Detect Unit -1 Sensory / Event Data , Air CE AAW Detect Unit-1 Engage Coordination & Status Data
Controls: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1
Inputs: Processed Air CE AAW Detect Unit -1 Sensory / Event Data , Air CE AAW Detect Unit-1 Engage Coordination & Status Data
Outputs: Air CE AAW Detect Unit-1 Processed Sensory Data, Air CE AAW Detect Unit-1 Status Data, Air CE AAW Unit-1 Detect to Engage Coordination Data
Controls: Issue Air CE AAW Action Detect Data Control
Mechanisms: (None)

[2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Inputs: TFCE AAW Related Fused Tactical Data, Surface to Air AAW CE Data, "Other" Air to Air-1 AAW CE Data, Air CE AAW Detect Unit-1 Processed Sensory Data, Air CE AAW Detect Unit-1 Status Data, Air CE AAW Engage Unit-1 Status Data
Outputs: Air-1 to "Other" Air AAW CE Data, Air to Surface AAW CE Data, AAW Action Process CE Status / Requests, AAW Action Process CE Tactical Data, Air CE AAW Engage Unit-1 Control Directives, Air CE AAW Action Unit-1 Target Engagement Data, Air CE AAW Detection Unit-1 Control Directives
Controls: AAW Related Environmental Constraints, TFCE AAW Command Directives, AAW Related Doctrine, AAW Related Mission Directives
Mechanisms: (None)
Sub-Activities: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1, [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1, [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1, [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1

[2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1
Inputs: Air CE AAW Unit-1 Assessed Current Situation, Air CE AAW Unit-1

Plan Effectiveness Assessment, Surface to Air-1 AAW CE Data, "Other" Air to Air-1 AAW CE Data, TFCE AAW Related Fused Tactical Data
Outputs: Air CE AAW Unit-1 Plan, Air CE AAW Unit-1 Plan Status / Requests
Controls: AAW Related Doctrine, AAW Related Mission Directives, AAW Related Environmental Constraints, Air CE AAW Unit-1 TFCE AAW Command Directives
Mechanisms: (None)

[2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1
Inputs: TFCE AAW Related Fused Tactical Data, "Other" Air to Air-1 AAW CE Data, Surface to Air-1 AAW CE Data, Air CE AAW Detect Unit-1 Status Data, Air CE AAW Unit-1 Assessed Current Situation, Air CE AAW Unit-1 Plan Effectiveness Assessment, Air CE AAW Detect Unit-1 Processed Sensory Data, Air CE AAW Unit-1 Execution Status Data, Air CE AAW Engage Unit-1 Status Data
Outputs: Air CE AAW Unit-1 Control Status / Requests, Air CE AAW Unit-1 Observed Fused Tactical Data, Current COA & Status, Air CE AAW Unit-1 Observed Current Situation
Controls: Air CE AAW Unit-1 Plan
Mechanisms: (None)

[2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Inputs: Air CE AAW Unit-1 Observed Fused Tactical Data, Current COA & Status, Air CE AAW Unit-1 Execution Status Data
Outputs: Air CE AAW Unit-1 Assess Status / Requests, Air CE AAW Unit-1 CE Tactical Data, Air CE AAW Unit-1 Assessed Fused Tactical Data, Air CE AAW Unit-1 Assessed Current Situation, Air CE AAW Unit-1 Plan Effectiveness Assessment
Controls: Air CE AAW Unit-1 Plan
Mechanisms: (None)

[2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Inputs: Air CE AAW Unit-1 Assessed Fused Tactical Data, Air CE AAW Unit-1 Observed Current Situation, Air CE AAW Unit-1 Plan Effectiveness Assessment
Outputs: Air CE AAW Unit-1 Execute

Status / Requests, Air-1 to "Other" Air AAW CE Data, Air Unit-1 to surface AAW CE Data, Air CE AAW Engage Unit-1 Control Directives, Air CE AAW Detection Unit-1 Control Directives, Air CE AAW Action Unit-1 Target Engagement Data, Air CE AAW Unit-1 Execution Status Data
Controls: Air CE AAW Unit-1 Plan
Mechanisms: (None)

[2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT]
PROCESS UNIT-1
Inputs: AAW "Targets", Air CE AAW Action Unit-1 Target Engagement Data, Air CE AAW Unit-1 Detect to Engage Coordination Data
Outputs: Defeated Enemy AAW Targets, Probe / Seek AAW "Target" Data, Unmolested Friendly AAW "Targets", Undamaged Neutral AAW "Targets", Air CE AAW Engage Unit-1 Status Data, Air CE AAW Unit-1 Engage to Detect Coordination Data
Controls: AAW Related Environmental Constraints, Air CE AAW Engage Unit-1 Control Directives
Mechanisms: (None)
Sub-Activities: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1, [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1, [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1, [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1, [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Inputs: Air CE AAW Action Unit-1 Target Engagement Data, Air CE AAW Unit-1 Detect to Engage Coordination Data
Outputs: Air CE AAW Engage Unit-1 Control Directives & Environmental Data, Received AIR CE AAW Engage Unit-1 Detect Coordination Data, Received Air CE AAW Engage Unit-1 Target Engagement Data
Controls: Air CE AAW Engage Unit-1 Control Directives, AAW Related Environmental Constraints
Mechanisms: (None)

[2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Inputs: AAW "Targets", Received AIR CE AAW Engage Unit-1 Detect Coordination Data, Received Air CE AAW Engage

Unit-1 Target Engagement Data, Air CE AAW Unit-1 Engage Feedback Requests / Status, Air CE AAW Unit-1 Engage Synchronization Requests / Status
Outputs: Defeated Enemy AAW Targets, Unmolested Friendly AAW "Targets", Undamaged Neutral AAW "Targets", Issue Air CE AAW Unit-1 Action Engage Data Control, Air CE AAW Unit-1 Engagement Implementation Status
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Mechanisms: (None)
Sub-Activities: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1 , [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1, [2.1.1.1.3.2.3] Air CE AAW Operate Sensors Unit-1, [2.1.1.1.3.2.4] Air CE AAW Control Platforms Unit-1, [2.1.1.1.3.2.5] Air CE AAW Energize Simulators / Stimulators Unit-1

[2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Inputs: Air CE AAW Unit-1 Simulator / Stimulator Status / Requests Data, Air CE AAW Unit-1 Engage Synchronization Requests / Status, Air CE AAW Unit-1 Engage Feedback Requests / Status, Received AIR CE AAW Engage Unit-1 Detect Coordination Data
Outputs: Issue Air CE AAW Unit-1 Action Engage Data Control, Air CE AAW Unit-1 Engagement Implementation Status, Air CE AAW Unit-1 Engagement Equipment Control Data
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1
Inputs: AAW "Targets", Received Air CE AAW Engage Unit-1 Target Engagement Data
Outputs: Defeated Enemy AAW Targets, Unmolested Friendly AAW "Targets", Undamaged Neutral AAW "Targets", Air CE AAW Unit-1 Weapons & CM Status / Requests Data
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data, Air CE AAW

Unit-1 Engagement Equipment Control Data
Mechanisms: (None)

[2.1.1.1.3.2.3] Air CE AAW Operate Sensors Unit-1
Inputs: (None)
Outputs: Air CE AAW Unit-1 Sensor Operations Status / Requests Data
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data, Air CE AAW Unit-1 Engagement Equipment Control Data
Mechanisms: (None)

[2.1.1.1.3.2.4] Air CE AAW Control Platforms Unit-1
Inputs: (None)
Outputs: Air CE AAW Unit-1 Platform Control Status / Requests Data
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data, Air CE AAW Unit-1 Engagement Equipment Control Data
Mechanisms: (None)

[2.1.1.1.3.2.5] Air CE AAW Energize Simulators / Stimulators Unit-1
Inputs: (None)
Outputs: Air CE AAW Unit-1 Simulator / Stimulator Status / Requests Data
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data, Air CE AAW Unit-1 Engagement Equipment Control Data
Mechanisms: (None)

[2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1
Inputs: Received AIR CE AAW Engage Unit-1 Detect Coordination Data, Received Air CE AAW Engage Unit-1 Target Engagement Data, Air CE AAW Unit-1 Engagement Implementation Status
Outputs: Air CE AAW Unit-1 Engage Feedback Requests / Status
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1

Inputs: Received AIR CE AAW Engage Unit-1 Detect Coordination Data, Received Air CE AAW Engage Unit-1 Target Engagement Data, Air CE AAW Unit-1 Engagement Implementation Status, Air CE AAW Unit-1 Engage Feedback Requests / Status
Outputs: Air CE AAW Unit-1 Engage Synchronization Requests / Status
Controls: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1
Inputs: Air CE AAW Unit-1 Engagement Implementation Status, Air CE AAW Unit-1 Engage Synchronization Requests / Status, Air CE AAW Unit-1 Engage Feedback Requests / Status, Air CE AAW Unit-1 Engage Synchronization Requests / Status
Outputs: Probe / Seek AAW "Target" Data, Air CE AAW Unit-1 Engage to Detect Coordination Data, Air CE AAW Engage Unit-1 Status Data
Controls: Issue Air CE AAW Unit-1 Action Engage Data Control, Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Mechanisms: (None)

[2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc.
[other]
Inputs: Air-1 to "Other" Air AAW CE Data, Surface to Air AAW CE Data, AAW "Targets", Unprocessed AAW "Target" Data, TFCE AAW Related Fused Tactical Data
Outputs: "Other" Air to Air-1 AAW CE Data, Air to Surface AAW CE Data, AAW Action Process CE Status / Requests, AAW Action Process CE Tactical Data, Undamaged Neutral AAW "Targets", Unmolested Friendly AAW "Targets", Defeated Enemy AAW Targets, Probe / Seek AAW "Target" Data
Controls: AAW Related Environmental Constraints, AAW Related Mission Directives, AAW Related Doctrine, TFCE AAW Command Directives
Mechanisms: (None)

[2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Inputs: AAW "Targets", Unprocessed AAW "Target" Data, TFCE AAW Related Fused Tactical Data, Air to Surface AAW CE Data
Outputs: Surface to Air AAW CE Data, AAW Action Process CE Status / Requests, AAW Action Process CE Tactical Data, Undamaged Neutral AAW "Targets",

Unmolested Friendly AAW "Targets", Defeated Enemy AAW Targets, Probe / Seek AAW "Target" Data
Controls: TFCE AAW Command Directives, AAW Related Doctrine, AAW Related Mission Directives, AAW Related Environmental Constraints
Mechanisms: (None)

[2.1.3] SPACE CE AAW ACTION PROCESS UNITS
Inputs: (None)
Outputs: (None)
Controls: TFCE AAW Command Directives
Mechanisms: (None)

[2.1.4] SUBMARINE CE AAW ACTION PROCESS UNITS
Inputs: (None)
Outputs: (None)
Controls: TFCE AAW Command Directives
Mechanisms: (None)

[2.2] TFCE "OTHER" WARFARE TASKS ACTION PROCESS
Inputs: (None)
Outputs: (None)
Controls: Environmental Constraints, Mission Directives, Doctrine, TFCE Command Directives
Mechanisms: (None)

Done.

APPENDIX C: Arrow Decomposition Report

[Diagram: -0]

Arrow: "Targets"
Input From: "Targets"
Input To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: "Targets"
Input From: {I1} "Targets"
Input To: [2] TFCE ACTION PROCESS

[Diagram: 2] TFCE ACTION PROCESS

Arrow: AAW "Targets"
Input From: {I3} "Targets"
Input To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: AAW "Targets"
Input From: {I3} AAW "Targets"
Input To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

Arrow: AAW "Targets"
Input From: {I3} AAW "Targets"
Input To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: AAW "Targets"
Input From: {I3} AAW "Targets"
Input To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2, 3, etc. [other]

Arrow: AAW "Targets"
Input From: {I3} AAW "Targets"
Input To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: AAW "Targets"
Input From: {I3} AAW "Targets"
Input To: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: AAW "Targets"
Input From: {I3} AAW "Targets"
Input To: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage

Implement Commands Unit-1

Arrow: AAW "Targets"
Input From: {I5} AAW "Targets"
Input To: [2.1.1.1.3.2.2] Air CE AAW
Actuate Weapons & Countermeasures Unit -1

[Diagram: -0]

Arrow: "Target" Information
Input From: "Target" Information
Input To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Externally Processed "Target" Data
Input From: {I2} "Target" Information
Input To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: External AAW "Target" Data
Input From: {I2} Externally Processed "Target" Data
Input To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: External AAW "Target" Data
Input From: {I2} External AAW "Target" Data
Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: External AAW "Target" Data
Input From: {I4} External AAW "Target" Data
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: Unprocessed "Target" Data
Input From: {I2} "Target" Information
Input To: [2] TFCE ACTION PROCESS

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Unprocessed AAW "Target" Data
Input From: {I2} Unprocessed "Target" Data
Input To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Unprocessed AAW "Target" Data
Input From: {I2} Unprocessed AAW "Target" Data
Input To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

Arrow: Unprocessed AAW "Target" Data
Input From: {I2} Unprocessed AAW "Target" Data
Input To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Unprocessed AAW "Target" Data
Input From: {I2} Unprocessed AAW "Target" Data
Input To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Unprocessed AAW "Target" Data
Input From: {I2} Unprocessed AAW "Target" Data
Input To: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Unprocessed AAW "Target" Data
Input From: {I1} Unprocessed AAW "Target" Data
Input To: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc

Arrow: Unprocessed AAW "Target" Data
Input From: {I2} Unprocessed AAW "Target" Data
Input To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2, 3, etc. [other]

[Diagram: -0]

Arrow: Mission Coordination Information
Input From: Mission Coordination Information
Input To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Mission Coordination Information
Input From: {I3} Mission Coordination Information
Input To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: AAW Coordination Data
Input From: {I1} Mission Coordination Information
Input To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: AAW Coordination Data
Input From: {I1} AAW Coordination Data
Input To: [1.1.1] PLAN TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: AAW Coordination Data
Input From: {I1} AAW Coordination Data
Input To: [1.1.1.1] Receive TFCE AAW Data for Planning

Arrow: AAW Coordination Data
Input From: {I1} AAW Coordination Data

Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: AAW Coordination Data
Input From: {I1} AAW Coordination Data
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: AAW Coordination Data
Input From: {I1} AAW Coordination Data
Input To: [1.1.3] ASSESS TFCE AAW PROCESS

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: AAW Coordination Data
Input From: {I2} AAW Coordination Data
Input To: [1.1.3.1] Receive TFCE AAW Data for Assessment

[Diagram: -0]

Arrow: Assigned Physical Resources / Materials [1]
Mechanism From: Assigned Physical Resources / Materials [1]
Mechanism To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: -0]

Arrow: Supporting Physical Resources / Materials [1]
Mechanism From: Supporting Physical Resources / Materials [1]
Mechanism To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: -0]

Arrow: Defeated Enemy Targets
Output From: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]
Output To: Defeated Enemy Targets

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Defeated Enemy Targets
Output From: [2] TFCE ACTION PROCESS
Output To: {O1} Defeated Enemy Targets

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Defeated Enemy AAW Targets
Output From: [2.1] TFCE AAW ACTION PROCESS
Output To: {O2} Defeated Enemy Targets

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Defeated Enemy AAW Targets
Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Output To: {O2} Defeated Enemy AAW Targets

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Defeated Enemy AAW Targets

Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS
UNITS 2,3, etc. [other]
Output To: {O2} Defeated Enemy AAW Targets

Arrow: Defeated Enemy AAW Targets
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS
UNIT-1
Output To: {O2} Defeated Enemy AAW Targets

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS
UNIT-1

Arrow: Defeated Enemy AAW Targets
Output From: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE
[ACT] PROCESS UNIT-1
Output To: {O2} Defeated Enemy AAW Targets

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE
[ACT] PROCESS UNIT-1

Arrow: Defeated Enemy AAW Targets
Output From: [2.1.1.1.3.2] Air CE AAW Engage
Implement Commands Unit-1
Output To: {O2} Defeated Enemy AAW Targets

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage
Implement Commands Unit-1

Arrow: Defeated Enemy AAW Targets
Output From: [2.1.1.1.3.2.2] Air CE AAW
Actuate Weapons & Countermeasures Unit -1
Output To: {O1} Defeated Enemy AAW Targets

Arrow: Defeated Enemy AAW Targets
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Output To: {O2} Defeated Enemy AAW Targets

[Diagram: -0]

Arrow: Unmolested Friendly "Targets"
Output From: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]
Output To: Unmolested Friendly "Targets"

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Unmolested Friendly "Targets"
Output From: [2] TFCE ACTION PROCESS
Output To: {O2} Unmolested Friendly "Targets"

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1] TFCE AAW ACTION PROCESS
Output To: {O3} Unmolested Friendly "Targets"

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Unmolested Friendly AAW "Targets"

Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Output To: {O3} Unmolested Friendly AAW "Targets"

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]
Output To: {O3} Unmolested Friendly AAW "Targets"

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Output To: {O3} Unmolested Friendly AAW "Targets"

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1
Output To: {O3} Unmolested Friendly AAW "Targets"

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Output To: {O3} Unmolested Friendly AAW "Targets"

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1
Output To: {O2} Unmolested Friendly AAW "Targets"

Arrow: Unmolested Friendly AAW "Targets"
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Output To: {O3} Unmolested Friendly AAW "Targets"

[Diagram: -0]

Arrow: Undamaged Neutral "Targets"
Output From: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]
Output To: Undamaged Neutral "Targets"

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Undamaged Neutral "Targets"
Output From: [2] TFCE ACTION PROCESS
Output To: {O3} Undamaged Neutral "Targets"

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1] TFCE AAW ACTION PROCESS
Output To: {O4} Undamaged Neutral "Targets"

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Output To: {O4} Undamaged Neutral AAW "Targets"

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]
Output To: {O4} Undamaged Neutral AAW "Targets"

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Output To: {O4} Undamaged Neutral AAW "Targets"

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1
Output To: {O4} Undamaged Neutral AAW "Targets"

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Output To: {O4} Undamaged Neutral AAW "Targets"

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1
Output To: {O3} Undamaged Neutral AAW "Targets"

Arrow: Undamaged Neutral AAW "Targets"
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Output To: {O4} Undamaged Neutral AAW "Targets"

[Diagram: -0]

Arrow: "Target" Information Interrogation
Output From: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]
Output To: "Target" Information Interrogation

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Solicit "Target" Data
Output From: [1] TFCE MANAGEMENT PROCESS
Output To: {O4} "Target" Information Interrogation

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: Solicit AAW "Target" Data
Output From: [1.1] TFCE AAW MANAGEMENT PROCESS
Output To: {O2} Solicit "Target" Data

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Solicit AAW "Target" Data
Output From: [1.1.2] OBSERVE TFCE AAW PROCESS
Output To: {O2} Solicit AAW "Target" Data

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Solicit AAW "Target" Data
Output From: [1.1.2.5] Issue TFCE AAW Observe Reports & Data
Output To: {O2} Solicit AAW "Target" Data

Arrow: Probe / Seek "Target" Data
Output From: [2] TFCE ACTION PROCESS
Output To: {O4} "Target" Information Interrogation

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Probe / Seek AAW "Target" Data
Output From: [2.1] TFCE AAW ACTION PROCESS
Output To: {O1} Probe / Seek "Target" Data

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Probe / Seek AAW "Target" Data
Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Output To: {O1} Probe / Seek AAW "Target" Data

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Probe / Seek AAW "Target" Data
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]
Output To: {O1} Probe / Seek AAW "Target" Data

Arrow: Probe / Seek AAW "Target" Data
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Output To: {O1} Probe / Seek AAW "Target" Data

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Probe / Seek AAW "Target" Data

Output From: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1
Output To: {O1} Probe / Seek AAW "Target" Data

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Probe / Seek AAW "Target" Data
Output From: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1
Output To: {O1} Probe / Seek AAW "Target" Data

Arrow: Probe / Seek AAW "Target" Data
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Output To: {O1} Probe / Seek AAW "Target" Data

[Diagram: -0]

Arrow: TFCE Status / Requests
Output From: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]
Output To: TFCE Status / Requests

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: TFCE Status / Requests
Output From: [1] TFCE MANAGEMENT PROCESS
Output To: {O5} TFCE Status / Requests

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: TFCE AAW Status / Requests
Output From: [1.1] TFCE AAW MANAGEMENT PROCESS
Output To: {O1} TFCE Status / Requests

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Plan Status / Requests
Output From: [1.1.1] PLAN TFCE AAW PROCESS
Output To: {O1} TFCE AAW Status / Requests

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Plan Status / Requests
Output From: [1.1.1.6] Issue Options, Plans & Updates
Output To: {O1} TFCE AAW Plan Status / Requests

Arrow: TFCE AAW Observe Status / Requests
Output From: [1.1.2] OBSERVE TFCE AAW PROCESS
Output To: {O1} TFCE AAW Status / Requests

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: TFCE AAW Observe Status / Requests
Output From: [1.1.2.5] Issue TFCE AAW Observe Reports & Data
Output To: {O1} TFCE AAW Observe Status / Requests

Arrow: TFCE AAW Assess Status / Requests
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Output To: {O1} TFCE AAW Status / Requests

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: TFCE AAW Assess Status / Requests
Output From: [1.1.3.6] Issue TFCE AAW Assessments & Reports
Output To: {O1} TFCE AAW Assess Status / Requests

Arrow: TFCE AAW Execute Status / Requests
Output From: [1.1.4] EXECUTE TFCE AAW PROCESS
Output To: {O1} TFCE AAW Status / Requests

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: TFCE AAW Execute Status / Requests
Output From: [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests
Output To: {O1} TFCE AAW Execute Status / Requests

[Diagram: -0]

Arrow: Mission Directives
Control From: Mission Directives
Control To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Mission Directives
Control From: {C2} Mission Directives
Control To: [2] TFCE ACTION PROCESS

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Mission Directives
Control From: {C3} Mission Directives
Control To: [2.2] TFCE "OTHER" WARFARE TASKS ACTION PROCESS

Arrow: AAW Related Mission Directives
Control From: {C3} Mission Directives
Control To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: AAW Related Mission Directives
Control From: {C3} AAW Related Mission Directives
Control To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: AAW Related Mission Directives
Control From: {C3} AAW Related Mission Directives
Control To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: AAW Related Mission Directives
Control From: {C3} AAW Related Mission Directives
Control To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: AAW Related Mission Directives
Control From: {C3} AAW Related Mission Directives
Control To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

Arrow: AAW Related Mission Directives
Control From: {C3} AAW Related Mission Directives
Control To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

Arrow: AAW Related Mission Directives
Control From: {C3} AAW Related Mission Directives
Control To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

Arrow: Mission Directives
Control From: {C2} Mission Directives
Control To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: AAW Related Directives
Control From: {C2} Mission Directives
Control To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: AAW Related Directives
Control From: {C2} AAW Related Directives
Control To: [1.1.1] PLAN TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: AAW Related Directives
Control From: {C2} AAW Related Directives
Control To: [1.1.1.1] Receive TFCE AAW Data for Planning

Arrow: Mission Directives
Control From: {C2} Mission Directives
Control To: [1.2] TFCE "OTHER" WARFARE TASKS MANAGEMENT PROCESS

[Diagram: -0]

Arrow: Doctrine
Control From: Doctrine
Control To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Doctrine
Control From: {C1} Doctrine
Control To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: AAW Related Doctrine
Control From: {C1} Doctrine
Control To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: AAW Related Doctrine
Control From: {C1} AAW Related Doctrine
Control To: [1.1.1] PLAN TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: AAW Related Doctrine
Control From: {C1} AAW Related Doctrine
Control To: [1.1.1.1] Receive TFCE AAW Data for Planning

Arrow: Doctrine
Control From: {C1} Doctrine
Control To: [1.2] TFCE "OTHER" WARFARE TASKS MANAGEMENT PROCESS

Arrow: Doctrine
Control From: {C1} Doctrine
Control To: [2] TFCE ACTION PROCESS

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Doctrine
Control From: {C2} Doctrine
Control To: [2.2] TFCE "OTHER" WARFARE TASKS ACTION PROCESS

Arrow: AAW Related Doctrine
Control From: {C2} Doctrine
Control To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: AAW Related Doctrine
Control From: {C2} AAW Related Doctrine
Control To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: AAW Related Doctrine
Control From: {C2} AAW Related Doctrine
Control To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: AAW Related Doctrine
Control From: {C2} AAW Related Doctrine
Control To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: AAW Related Doctrine
Control From: {C2} AAW Related Doctrine
Control To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

Arrow: AAW Related Doctrine
Control From: {C2} AAW Related Doctrine
Control To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

Arrow: AAW Related Doctrine
Control From: {C2} AAW Related Doctrine
Control To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

[Diagram: -0]

Arrow: Environmental Constraints
Control From: Environmental Constraints
Control To: [0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Environmental Constraints
Control From: {C3} Environmental Constraints
Control To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: Environmental Constraints
Control From: {C3} Environmental Constraints
Control To: [1.2] TFCE "OTHER" WARFARE TASKS MANAGEMENT PROCESS

Arrow: AAW Related Environmental Constraints
Control From: {C3} Environmental Constraints
Control To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: AAW Related Environmental Constraints
Control From: {C3} AAW Related Environmental Constraints
Control To: [1.1.1] PLAN TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: AAW Related Environmental Constraints
Control From: {C3} AAW Related Environmental Constraints
Control To: [1.1.1.1] Receive TFCE AAW Data for

Planning

Arrow: Environmental Constraints
Control From: {C3} Environmental Constraints
Control To: [2] TFCE ACTION PROCESS

[Diagram: 2] TFCE ACTION PROCESS

Arrow: Environmental Constraints
Control From: {C4} Environmental Constraints
Control To: [2.2] TFCE "OTHER" WARFARE TASKS ACTION PROCESS

Arrow: AAW Related Environmental Constraints
Control From: {C4} Environmental Constraints
Control To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: AAW Related Environmental Constraints
Control From: {C2} AAW Related Environmental Constraints
Control To: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental

Constraints
Control To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: AAW Related Environmental Constraints
Control From: {C1} AAW Related Environmental Constraints
Control To: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

Arrow: AAW Related Environmental Constraints
Control From: {C4} AAW Related Environmental Constraints
Control To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: TFCE Command Directives
Output From: [1] TFCE MANAGEMENT PROCESS
Control To: [2] TFCE ACTION PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: TFCE AAW Command Directives
Output From: [1.1] TFCE AAW MANAGEMENT PROCESS
Output To: {O3} TFCE Command Directives

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Command Directives
Output From: [1.1.4] EXECUTE TFCE AAW PROCESS
Output To: {O3} TFCE AAW Command Directives

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: TFCE AAW Command Directives
Output From: [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests
Output To: {O2} TFCE AAW Command Directives

Arrow: TFCE Command Directives
Control From: {C1} TFCE Command Directives
Control To: [2.2] TFCE "OTHER" WARFARE TASKS ACTION PROCESS

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE Command Directives
Control To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.3] SPACE CE AAW ACTION PROCESS UNITS

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.4] SUBMARINE CE AAW ACTION PROCESS UNITS

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

Arrow: TFCE AAW Command Directives
Control From: {C1} TFCE AAW Command Directives
Control To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: TFCE Fused Tactical Data
Output From: [1] TFCE MANAGEMENT PROCESS
Input To: [2] TFCE ACTION PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: TFCE Fused AAW Tactical Data / Picture

Output From: [1.1] TFCE AAW MANAGEMENT PROCESS
Output To: {O4} TFCE Fused Tactical Data

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE Fused AAW Tactical Data / Picture
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Output To: {O4} TFCE Fused AAW Tactical Data / Picture

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: TFCE Fused AAW Tactical Data / Picture
Output From: [1.1.3.6] Issue TFCE AAW Assessments & Reports
Output To: {O2} TFCE Fused AAW Tactical Data / Picture

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I1} TFCE Fused Tactical Data
Input To: [2.1] TFCE AAW ACTION PROCESS

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I1} TFCE AAW Related Fused Tactical Data
Input To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I1} TFCE AAW Related Fused Tactical Data
Input To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I1} TFCE AAW Related Fused Tactical Data
Input To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I1} TFCE AAW Related Fused Tactical Data
Input To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I3} TFCE AAW Related Fused Tactical Data
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I3} TFCE AAW Related Fused Tactical Data
Input To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

Arrow: TFCE AAW Related Fused Tactical Data
Input From: {I1} TFCE AAW Related Fused Tactical Data
Input To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Action Process CE Status / Requests
Output From: [2] TFCE ACTION PROCESS
Input To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: Action Process AAW CE Status / Requests
Input From: {I4} Action Process CE Status / Requests
Input To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Action Process AAW CE Status / Requests
Input From: {I4} Action Process AAW CE Status / Requests
Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Action Process AAW CE Status / Requests
Input From: {I2} Action Process AAW CE Status / Requests
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: AAW Action Process CE Status / Requests
Output From: [2.1] TFCE AAW ACTION PROCESS
Output To: {O6} Action Process CE Status / Requests

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: AAW Action Process CE Status / Requests
Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Output To: {O6} AAW Action Process CE Status / Requests

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: AAW Action Process CE Status / Requests
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2, 3, etc. [other]
Output To: {O6} AAW Action Process CE Status / Requests

Arrow: AAW Action Process CE Status / Requests
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Output To: {O6} AAW Action Process CE Status / Requests

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: AAW Action Process CE Status / Requests
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Output To: {O6} AAW Action Process CE Status / Requests

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan Status / Requests
Output From: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1
Output To: {O3} AAW Action Process CE Status / Requests

Arrow: Air CE AAW Unit-1 Control Status / Requests
Output From: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1
Output To: {O3} AAW Action Process CE Status / Requests

Arrow: Air CE AAW Unit-1 Assess Status / Requests
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Output To: {O3} AAW Action Process CE Status / Requests

Arrow: Air CE AAW Unit-1 Execute Status / Requests
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Output To: {O3} AAW Action Process CE Status / Requests

Arrow: AAW Action Process CE Status / Requests
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Output To: {O6} AAW Action Process CE Status / Requests

[Diagram: 0] TASK FORCE COOPERATIVE ENGAGEMENT PROCESS [TFCE]

Arrow: Action Process CE Tactical Data
Output From: [2] TFCE ACTION PROCESS
Input To: [1] TFCE MANAGEMENT PROCESS

[Diagram: 1] TFCE MANAGEMENT PROCESS

Arrow: Action Process AAW CE Tactical Data
Input From: {I3} Action Process CE Tactical Data
Input To: [1.1] TFCE AAW MANAGEMENT PROCESS

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Action Process AAW CE Tactical Data
Input From: {I3} Action Process AAW CE Tactical Data
Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Action Process AAW CE Tactical Data
Input From: {I3} Action Process AAW CE Tactical Data
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: AAW Action Process CE Tactical Data
Output From: [2.1] TFCE AAW ACTION PROCESS
Output To: {O5} Action Process CE Tactical Data

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: AAW Action Process CE Tactical Data
Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Output To: {O5} AAW Action Process CE Tactical Data

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: AAW Action Process CE Tactical Data
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2, 3, etc. [other]
Output To: {O5} AAW Action Process CE Tactical Data

Arrow: AAW Action Process CE Tactical Data
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Output To: {O5} AAW Action Process CE Tactical Data

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: AAW Action Process CE Tactical Data
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Output To: {O5} AAW Action Process CE Tactical Data

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 CE Tactical Data
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Output To: {O2} AAW Action Process CE Tactical Data

Arrow: AAW Action Process CE Tactical Data
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Output To: {O5} AAW Action Process CE Tactical Data

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Plan
Output From: [1.1.1] PLAN TFCE AAW PROCESS
Control To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.2.2] Maintain TFCE AAW Data

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.2.3] Characterize TFCE AAW Data

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.2.4] Generate TFCE AAW Tactical Picture

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.2.5] Issue TFCE AAW Observe Reports & Data

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Plan
Output From: [1.1.1] PLAN TFCE AAW PROCESS
Control To: [1.1.3] ASSESS TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Plan
Output From: [1.1.1.6] Issue Options, Plans & Updates
Output To: {O2} TFCE AAW Plan

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.3.2] Characterize Current TFCE AAW Situation

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.3.3] Assess TFCE AAW Plan Progress

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.3.4] ASSESS TFCE AAW Plan Effectiveness

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.3.6] Issue TFCE AAW Assessments & Reports

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.3.5] Conduct TFCE AAW Mission Assessment

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.3.1] Receive TFCE AAW Data for Assessment

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Plan
Output From: [1.1.1] PLAN TFCE AAW PROCESS
Control To: [1.1.4] EXECUTE TFCE AAW PROCESS

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests

Arrow: TFCE AAW Plan

Control From: {C1} TFCE AAW Plan
Control To: [1.1.4.3] Schedule TFCE AAW Resourses

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.4.2] Identify Current TFCE AAW COA

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.4.1] Receive TFCE AAW Plans, Data & Status

Arrow: TFCE AAW Plan
Control From: {C1} TFCE AAW Plan
Control To: [1.1.4.4] Generate TFCE AAW Commands

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Observed Current TFCE AAW Situation Data
Output From: [1.1.2] OBSERVE TFCE AAW PROCESS
Input To: [1.1.4] EXECUTE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Observed Current TFCE AAW Situation Data
Output From: [1.1.2.5] Issue TFCE AAW Observe Reports & Data
Output To: {O4} Observed Current TFCE AAW Situation Data

Arrow: Observed Current TFCE AAW Situation Data
Input From: {I3} Observed Current TFCE AAW Situation Data
Input To: [1.1.4.1] Receive TFCE AAW Plans, Data & Status

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Observed TFCE AAW Tactical Picture, Current COA & Status
Output From: [1.1.2] OBSERVE TFCE AAW PROCESS
Input To: [1.1.3] ASSESS TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Observed TFCE AAW Tactical Picture, Current COA & Status
Output From: [1.1.2.5] Issue TFCE AAW Observe Reports & Data
Output To: {O3} Observed TFCE AAW Tactical Picture, Current COA & Status

Arrow: Observed TFCE AAW Tactical Picture, Current COA & Status
Input From: {I1} Observed TFCE AAW Tactical Picture, Current COA & Status
Input To: [1.1.3.1] Receive TFCE AAW Data for Assessment

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Assessed TFCE AAW Tactical Picture
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Input To: [1.1.4] EXECUTE TFCE AAW PROCESS

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: Assessed TFCE AAW Tactical Picture

Output From: [1.1.3.6] Issue TFCE AAW Assessments & Reports
Output To: {O3} Assessed TFCE AAW Tactical Picture

Arrow: Assessed TFCE AAW Tactical Picture
Input From: {I1} Assessed TFCE AAW Tactical Picture
Input To: [1.1.4.1] Receive TFCE AAW Plans, Data & Status

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Input To: [1.1.4] EXECUTE TFCE AAW PROCESS

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness
Input From: {I2} Assessed TFCE AAW Plan Effectiveness
Input To: [1.1.4.1] Receive TFCE AAW Plans, Data & Status

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness
Input From: {I7} Assessed TFCE AAW Plan Effectiveness
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: Assessed TFCE AAW Plan Effectiveness
Output From: [1.1.3.6] Issue TFCE AAW Assessments & Reports
Output To: {O4} Assessed TFCE AAW Plan Effectiveness

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Input To: [1.1.1] PLAN TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness
Input From: {I2} Assessed TFCE AAW Plan Effectiveness
Input To: [1.1.1.1] Receive TFCE AAW Data for Planning

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Assessed Current TFCE AAW Situation
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Assessed Current TFCE AAW Situation
Input From: {I5} Assessed Current TFCE AAW Situation
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

Arrow: Assessed Current TFCE AAW Situation
Output From: [1.1.3.6] Issue TFCE AAW Assessments & Reports
Output To: {O5} Assessed Current TFCE AAW Situation

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: Assessed Current TFCE AAW Situation
Output From: [1.1.3] ASSESS TFCE AAW PROCESS
Input To: [1.1.1] PLAN TFCE AAW PROCESS

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: Assessed Current TFCE AAW Situation
Input From: {I3} Assessed Current TFCE AAW Situation
Input To: [1.1.1.1] Receive TFCE AAW Data for Planning

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Execution Status Data
Output From: [1.1.4] EXECUTE TFCE AAW PROCESS
Input To: [1.1.3] ASSESS TFCE AAW PROCESS

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: TFCE AAW Execution Status Data
Input From: {I3} TFCE AAW Execution Status Data
Input To: [1.1.3.1] Receive TFCE AAW Data for Assessment

Arrow: TFCE AAW Execution Status Data
Output From: [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests
Output To: {O3} TFCE AAW Execution Status Data

[Diagram: 1.1] TFCE AAW MANAGEMENT PROCESS

Arrow: TFCE AAW Execution Status Data
Output From: [1.1.4] EXECUTE TFCE AAW PROCESS
Input To: [1.1.2] OBSERVE TFCE AAW PROCESS

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: TFCE AAW Execution Status Data
Input From: {I6} TFCE AAW Execution Status Data
Input To: [1.1.2.1] Receive TFCE AAW Data for Observe

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Doctrine, Mission Directives & Constraints data
Output From: [1.1.1.1] Receive TFCE AAW Data for Planning
Control To: [1.1.1.2] Define & Bound TFCE AAW Mission

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Mission Statement
Output From: [1.1.1.2] Define & Bound TFCE AAW Mission
Control To: [1.1.1.3] Develop Alternate TFCE AAW COAs

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Mission Status & Descriptive Data
Output From: [1.1.1.2] Define & Bound TFCE AAW Mission
Input To: [1.1.1.3] Develop Alternate TFCE AAW COAs

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Coordination & Situation Assessment Data
Output From: [1.1.1.1] Receive TFCE AAW Data for Planning
Input To: [1.1.1.2] Define & Bound TFCE AAW Mission

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Mission Statement
Output From: [1.1.1.2] Define & Bound TFCE AAW Mission
Control To: [1.1.1.4] Select Prospective TFCE AAW COAs

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Mission Status & Descriptive Data
Output From: [1.1.1.2] Define & Bound TFCE AAW Mission
Input To: [1.1.1.4] Select Prospective TFCE AAW COAs

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: Alternative TFCE AAW COAs
Output From: [1.1.1.3] Develop Alternate TFCE AAW COAs
Input To: [1.1.1.4] Select Prospective TFCE AAW COAs

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: Primary & Contingency COAs
Output From: [1.1.1.4] Select Prospective TFCE AAW COAs
Input To: [1.1.1.5] Generate TFCE AAW Plans & Updates

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Mission Statement
Output From: [1.1.1.2] Define & Bound TFCE AAW Mission
Control To: [1.1.1.5] Generate TFCE AAW Plans & Updates

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Mission Status & Descriptive Data
Output From: [1.1.1.2] Define & Bound TFCE AAW Mission
Input To: [1.1.1.5] Generate TFCE AAW Plans & Updates

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: Current TFCE AAW Plan & Annexes
Output From: [1.1.1.5] Generate TFCE AAW Plans & Updates
Input To: [1.1.1.6] Issue Options, Plans & Updates

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: Issue TFCE AAW Planning data Control
Output From: [1.1.1.5] Generate TFCE AAW Plans & Updates

Control To: [1.1.1.6] Issue Options, Plans & Updates

[Diagram: 1.1.1] PLAN TFCE AAW PROCESS

Arrow: TFCE AAW Planning Status / Requests Data
Output From: [1.1.1.5] Generate TFCE AAW Plans & Updates
Input To: [1.1.1.6] Issue Options, Plans & Updates

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: TFCE AAW Coordination, Situation Status / Requests, Communications Data
Output From: [1.1.2.1] Receive TFCE AAW Data for Observe
Input To: [1.1.2.2] Maintain TFCE AAW Data

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: TFCE AAW Tactical Events / "Target" Data
Output From: [1.1.2.1] Receive TFCE AAW Data for Observe
Input To: [1.1.2.2] Maintain TFCE AAW Data

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Current Updated / Tested Archived TFCE AAW Data
Output From: [1.1.2.2] Maintain TFCE AAW Data
Input To: [1.1.2.3] Characterize TFCE AAW Data

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Sorted & Associated TFCE AAW Tactical Events Data
Output From: [1.1.2.3] Characterize TFCE AAW Data
Input To: [1.1.2.4] Generate TFCE AAW Tactical Picture

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Compiled TFCE AAW Resource Status & Condition Data
Output From: [1.1.2.3] Characterize TFCE AAW Data
Input To: [1.1.2.4] Generate TFCE AAW Tactical Picture

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Observed TFCE AAW Tactical Picture Data
Output From: [1.1.2.4] Generate TFCE AAW Tactical Picture
Input To: [1.1.2.5] Issue TFCE AAW Observe Reports & Data

[Diagram: 1.1.2] OBSERVE TFCE AAW PROCESS

Arrow: Observed Current TFCE AAW Situation Status / Requests Data
Output From: [1.1.2.3] Characterize TFCE AAW Data
Input To: [1.1.2.5] Issue TFCE AAW Observe Reports & Data

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: Current TFCE AAW Composite Situation Data
Output From: [1.1.3.1] Receive TFCE AAW Data for Assessment
Input To: [1.1.3.2] Characterize Current TFCE AAW Situation

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: Characterized TFCE AAW Composite Situation Data
Output From: [1.1.3.2] Characterize Current TFCE AAW Situation
Input To: [1.1.3.3] Assess TFCE AAW Plan Progress

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: Current TFCE AAW Situation Vs. Planned Progress Data
Output From: [1.1.3.3] Assess TFCE AAW Plan Progress
Input To: [1.1.3.4] ASSESS TFCE AAW Plan Effectiveness

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: TFCE AAW Plan Effectiveness Assessment Data
Output From: [1.1.3.4] ASSESS TFCE AAW Plan Effectiveness
Input To: [1.1.3.5] Conduct TFCE AAW Mission Assessment

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: Assessed TFCE AAW Plan Effectiveness Data
Output From: [1.1.3.4] ASSESS TFCE AAW Plan Effectiveness
Input To: [1.1.3.6] Issue TFCE AAW Assessments & Reports

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: TFCE AAW Mission Status / Requests & Situation Data
Output From: [1.1.3.5] Conduct TFCE AAW Mission Assessment
Input To: [1.1.3.6] Issue TFCE AAW Assessments & Reports

[Diagram: 1.1.3] ASSESS TFCE AAW PROCESS

Arrow: TFCE AAW Fused Tactical Picture & Tactical Data
Output From: [1.1.3.5] Conduct TFCE AAW Mission Assessment
Input To: [1.1.3.6] Issue TFCE AAW Assessments & Reports

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: Current [Observed Only] TFCE AAW Situation Data
Output From: [1.1.4.1] Receive TFCE AAW Plans, Data & Status
Input To: [1.1.4.2] Identify Current TFCE AAW COA

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: Assessed TFCE AAW Situation Data
Output From: [1.1.4.1] Receive TFCE AAW Plans, Data & Status
Input To: [1.1.4.2] Identify Current TFCE AAW COA

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: Current TFCE AAW COA & Situation Data
Output From: [1.1.4.2] Identify Current TFCE AAW COA
Input To: [1.1.4.3] Schedule TFCE AAW Resourses

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: TFCE AAW Tasks to Resourses Mapping & Employment Data
Output From: [1.1.4.3] Schedule TFCE AAW Resourses
Input To: [1.1.4.4] Generate TFCE AAW Commands

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: TFCE AAW Assigned Action Process Command Directives
Output From: [1.1.4.4] Generate TFCE AAW Commands
Input To: [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests

---

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: TFCE AAW Execute Status / Requests Data
Output From: [1.1.4.3] Schedule TFCE AAW Resourses
Input To: [1.1.4.5] Issue TFCE AAW Command Directives Reports / Requests

---

[Diagram: 1.1.4] EXECUTE TFCE AAW PROCESS

Arrow: Current TFCE AAW COA & Situation Data
Output From: [1.1.4.2] Identify Current TFCE AAW COA
Input To: [1.1.4.4] Generate TFCE AAW Commands

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Air to Surface AAW CE Data
Output From: [2.1.1] AIR CE AAW ACTION PROCESS UNITS
Input To: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Air to Surface AAW CE Data
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]
Output To: {O7} Air to Surface AAW CE Data

Arrow: Air to Surface AAW CE Data
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Output To: {O7} Air to Surface AAW CE Data

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air to Surface AAW CE Data
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Output To: {O7} Air to Surface AAW CE Data

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air Unit-1 to surface AAW CE Data
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Output To: {O4} Air to Surface AAW CE Data

[Diagram: 2.1] TFCE AAW ACTION PROCESS

Arrow: Surface to Air AAW CE Data
Output From: [2.1.2] SURFACE CE AAW ACTION PROCESS UNITS
Input To: [2.1.1] AIR CE AAW ACTION PROCESS UNITS

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Surface to Air AAW CE Data
Input From: {I4} Surface to Air AAW CE Data
Input To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc.
[other]

Arrow: Surface to Air AAW CE Data
Input From: {I4} Surface to Air AAW CE Data
Input To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Surface to Air AAW CE Data
Input From: {I4} Surface to Air AAW CE Data
Input To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E]
PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E]
PROCESS UNIT-1

Arrow: Surface to Air-1 AAW CE Data
Input From: {I4} Surface to Air AAW CE Data
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe
Process Unit-1

Arrow: Surface to Air-1 AAW CE Data
Input From: {I4} Surface to Air AAW CE Data
Input To: [2.1.1.1.2.1] Air CE AAW Control Plan Process
Unit-1

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: Air-1 to "Other" Air AAW CE Data
Output From: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1
Input To: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc. [other]

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air-1 to "Other" Air AAW CE Data
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E]
PROCESS UNIT-1
Output To: {O8} Air-1 to "Other" Air AAW CE Data

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E]
PROCESS UNIT-1

Arrow: Air-1 to "Other" Air AAW CE Data
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process
Unit-1
Output To: {O5} Air-1 to "Other" Air AAW CE Data

[Diagram: 2.1.1] AIR CE AAW ACTION PROCESS UNITS

Arrow: "Other" Air to Air-1 AAW CE Data
Output From: [2.1.1.2] AIR CE AAW ACTION PROCESS UNITS 2,3, etc.
[other]

Input To: [2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: "Other" Air to Air-1 AAW CE Data
Input From: {I5} "Other" Air to Air-1 AAW CE Data
Input To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: "Other" Air to Air-1 AAW CE Data
Input From: {I5} "Other" Air to Air-1 AAW CE Data
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

Arrow: "Other" Air to Air-1 AAW CE Data
Input From: {I5} "Other" Air to Air-1 AAW CE Data
Input To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Control Directives
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Control To: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Control Directives
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Output To: {O6} Air CE AAW Engage Unit-1 Control Directives

Arrow: Air CE AAW Engage Unit-1 Control Directives
Control From: {C1} Air CE AAW Engage Unit-1 Control Directives
Control To: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Action Unit-1 Target Engagement Data
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Input To: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Action Unit-1 Target Engagement Data
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Output To: {O7} Air CE AAW Action Unit-1 Target Engagement Data

Arrow: Air CE AAW Action Unit-1 Target Engagement Data
Input From: {I1} Air CE AAW Action Unit-1 Target Engagement Data

Input To: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Detection Unit-1 Control Directives
Output From: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1
Control To: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Detection Unit-1 Control Directives
Control From: {C2} Air CE AAW Detection Unit-1 Control Directives
Control To: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc

Arrow: Air CE AAW Detection Unit-1 Control Directives
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Output To: {O1} Air CE AAW Detection Unit-1 Control Directives

---

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Detect Unit-1 Processed Sensory Data
Output From: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1
Input To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Detect Unit-1 Processed Sensory Data
Output From: [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1
Output To: {O1} Air CE AAW Detect Unit-1 Processed Sensory Data

Arrow: Air CE AAW Detect Unit-1 Processed Sensory Data
Input From: {I1} Air CE AAW Detect Unit-1 Processed Sensory Data
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Detect Unit-1 Status Data
Output From: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1
Input To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Detect Unit-1 Status Data
Output From: [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1
Output To: {O2} Air CE AAW Detect Unit-1 Status Data

Arrow: Air CE AAW Detect Unit-1 Status Data
Input From: {I2} Air CE AAW Detect Unit-1 Status Data
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Detect to Engage Coordination Data
Output From: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1
Input To: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Detect to Engage Coordination Data
Output From: [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1
Output To: {O3} Air CE AAW Unit-1 Detect to Engage Coordination Data

Arrow: Air CE AAW Unit-1 Detect to Engage Coordination Data
Input From: {I2} Air CE AAW Unit-1 Detect to Engage Coordination Data
Input To: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Status Data
Output From: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1
Input To: [2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Status Data
Input From: {I6} Air CE AAW Engage Unit-1 Status Data
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

Arrow: Air CE AAW Engage Unit-1 Status Data
Output From: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1
Output To: {O6} Air CE AAW Engage Unit-1 Status Data

[Diagram: 2.1.1.1] AIR CE AAW ACTION PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage to Detect Coordination Data
Output From: [2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1
Input To: [2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage to Detect Coordination Data
Input From: {I2} Air CE AAW Unit-1 Engage to Detect Coordination

Data
Input To: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc

Arrow: Air CE AAW Unit-1 Engage to Detect Coordination Data
Output From: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1
Output To: {O5} Air CE AAW Unit-1 Engage to Detect Coordination Data

---

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Received Air CE AAW Detect Unit-1 Sensor(s) Data
Output From: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc
Input To: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Received Air CE AAW Detect Unit-1 Sensor(s) Data
Input From: {I2} Received Air CE AAW Detect Unit-1 Sensor(s) Data
Input To: [2.1.1.1.1.2.1] Air CE AAW Detect Sense Sensory Data Unit-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Output From: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc
Control To: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Detection Unit-1 Control Directives & Environmental
Control To: [2.1.1.1.1.2.3] Air CE AAW Detect Estimate Background Unit-1

Arrow: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Detection Unit-1 Control Directives & Environmental
Control To: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1

Arrow: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Detection Unit-1 Control Directives & Environmental
Control To: [2.1.1.1.1.2.4] Air CE AAW Detect Set Thresholds

Unit-1

Arrow: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Detection Unit-1 Control Directives & Environmental
Control To: [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1

Arrow: Air CE AAW Detection Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Detection Unit-1 Control Directives & Environmental
Control To: [2.1.1.1.1.2.1] Air CE AAW Detect Sense Sensory Data Unit-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Issue Air CE AAW Action Detect Data Control
Output From: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1
Control To: [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Issue Air CE AAW Action Detect Data Control
Output From: [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1
Output To: {O2} Issue Air CE AAW Action Detect Data Control

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Processed Air CE AAW Detect Unit -1 Sensory / Event Data
Output From: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1
Input To: [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Processed Air CE AAW Detect Unit -1 Sensory / Event Data
Output From: [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1
Output To: {O3} Processed Air CE AAW Detect Unit -1 Sensory / Event Data

---

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Detect Unit-1 Engage Coordination & Status Data
Output From: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1
Input To: [2.1.1.1.1.3] Air CE AAW Detect Issue Data Reports Process Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event

Data

Arrow: Air CE AAW Detect Unit-1 Engage Coordination & Status Data
Output From: [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1
Output To: {O4} Air CE AAW Detect Unit-1 Engage Coordination & Status Data

---

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Received Air CE AAW Detect Unit-1 Engage Coordination Data
Output From: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc
Input To: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Received Air CE AAW Detect Unit-1 Engage Coordination Data
Input From: {I1} Received Air CE AAW Detect Unit-1 Engage Coordination Data
Input To: [2.1.1.1.1.2.4] Air CE AAW Detect Set Thresholds Unit-1

Arrow: Received Air CE AAW Detect Unit-1 Engage Coordination Data
Input From: {I1} Received Air CE AAW Detect Unit-1 Engage Coordination Data
Input To: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1

[Diagram: 2.1.1.1.1] AIR CE AAW ACTION DETECT [SENSE] PROCESS UNIT-1

Arrow: Air CE AAW Detection Unit-1 Sensor(s) Control Data
Output From: [2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data Process Unit-1
Control To: [2.1.1.1.1.1] Air CE AAW Detect Receive Own Local & Remote Sensor Data Proc

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detection Unit-1 Sensor(s) Control Data
Output From: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1
Output To: {O1} Air CE AAW Detection Unit-1 Sensor(s) Control Data

---

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detect Unit-1 Unprocessed Sensory Data
Output From: [2.1.1.1.1.2.1] Air CE AAW Detect Sense Sensory Data Unit-1
Input To: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detect Unit-1 Background Data

Output From: [2.1.1.1.1.2.3] Air CE AAW Detect Estimate Background Unit-1
Input To: [2.1.1.1.1.2.4] Air CE AAW Detect Set Thresholds Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detect Unit-1 Threshold Control Data
Output From: [2.1.1.1.1.2.4] Air CE AAW Detect Set Thresholds Unit-1
Control To: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detect Unit-1 Processed Sensory Data
Output From: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1
Input To: [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1

[Diagram: 2.1.1.1.1.2] Air CE AAW Detect Generate Sensory / Event Data

Arrow: Air CE AAW Detect Unit-1 Process Sonsory Data Status & Engage Coordination Requests
Output From: [2.1.1.1.1.2.2] Air CE AAW Detect Process Sensed Data Unit-1
Input To: [2.1.1.1.1.2.5] Air CE AAW Detect Format Threshold Crossing Events Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan
Output From: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1
Control To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan
Output From: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1
Control To: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan
Output From: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1
Control To: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Assessed Fused Tactical Data
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Input To: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Observed Fused Tactical Data, Current COA &

Status
Output From: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1
Input To: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Observed Current Situation
Output From: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1
Input To: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Assessed Current Situation
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Assessed Current Situation
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Input To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan Effectiveness Assessment
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Input To: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan Effectiveness Assessment
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Plan Effectiveness Assessment
Output From: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1
Input To: [2.1.1.1.2.1] Air CE AAW Control Plan Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Execution Status Data
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Input To: [2.1.1.1.2.2] Air CE AAW Control Observe Process Unit-1

[Diagram: 2.1.1.1.2] AIR CE AAW ACTION CONTROL [POA&E] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Execution Status Data
Output From: [2.1.1.1.2.4] Air CE AAW Control Execute Process Unit-1
Input To: [2.1.1.1.2.3] Air CE AAW Control Assess Process Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Issue Air CE AAW Unit-1 Action Engage Data Control
Output From: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Control To: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Issue Air CE AAW Unit-1 Action Engage Data Control
Output From: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Output To: {O4} Issue Air CE AAW Unit-1 Action Engage Data Control

---

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Control To: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Engage Unit-1 Control Directives & Environmental Dat
Control To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Engage Unit-1 Control Directives & Environmental Dat
Control To: [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Engage Unit-1 Control Directives & Environmental Dat
Control To: [2.1.1.1.3.2.3] Air CE AAW Operate Sensors Unit-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Engage Unit-1 Control Directives & Environmental Dat
Control To: [2.1.1.1.3.2.4] Air CE AAW Control Platforms Unit-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Control From: {C1} Air CE AAW Engage Unit-1 Control Directives & Environmental Dat
Control To: [2.1.1.1.3.2.5] Air CE AAW Energize Simulators / Stimulators Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Control To: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental

Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Control To: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Received AIR CE AAW Engage Unit-1 Detect Coordination Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Input To: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Received AIR CE AAW Engage Unit-1 Detect Coordination Data
Input From: {I2} Received AIR CE AAW Engage Unit-1 Detect Coordination Data
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Received AIR CE AAW Engage Unit-1 Detect Coordination Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Input To: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Received AIR CE AAW Engage Unit-1 Detect Coordination Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Input To: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Received Air CE AAW Engage Unit-1 Target Engagement Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Input To: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Received Air CE AAW Engage Unit-1 Target Engagement Data
Input From: {I1} Received Air CE AAW Engage Unit-1 Target Engagement Data
Input To: [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Received Air CE AAW Engage Unit-1 Target Engagement Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Input To: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Received Air CE AAW Engage Unit-1 Target Engagement Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Input To: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engagement Implementation Status

Output From: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Input To: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engagement Implementation Status
Output From: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Input To: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engagement Implementation Status
Output From: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Output To: {O5} Air CE AAW Unit-1 Engagement Implementation Status

---

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engagement Implementation Status
Output From: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1
Input To: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage Synchronization Requests / Status
Output From: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1
Input To: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage Feedback Requests / Status
Output From: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1
Input To: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage Feedback Requests / Status
Output From: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1
Input To: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage Feedback Requests / Status
Output From: [2.1.1.1.3.3] Air CE AAW Engage Action Feedback Unit-1
Input To: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engage Feedback Requests / Status
Input From: {I4} Air CE AAW Unit-1 Engage Feedback Requests / Status
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage Synchronization Requests / Status

Output From: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1
Input To: [2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engage Synchronization Requests / Status
Input From: {I3} Air CE AAW Unit-1 Engage Synchronization Requests / Status
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Unit-1 Engage Synchronization Requests / Status
Output From: [2.1.1.1.3.4] Air CE AAW Engage Synchronize Action Unit-1
Input To: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[Diagram: 2.1.1.1.3] AIR CE AAW ACTION ENGAGE [ACT] PROCESS UNIT-1

Arrow: Air CE AAW Engage Unit-1 Control Directives & Environmental Data
Output From: [2.1.1.1.3.1] Air CE AAW Engage Receive Commands Unit-1
Control To: [2.1.1.1.3.5] Air CE AAW Engage Issue Actions & Feedback Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engagement Equipment Control Data
Output From: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Control To: [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engagement Equipment Control Data
Output From: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Control To: [2.1.1.1.3.2.3] Air CE AAW Operate Sensors Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engagement Equipment Control Data
Output From: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Control To: [2.1.1.1.3.2.4] Air CE AAW Control Platforms Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Engagement Equipment Control Data
Output From: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1
Control To: [2.1.1.1.3.2.5] Air CE AAW Energize Simulators / Stimulators Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Simulator / Stimulator Status / Requests Data
Output From: [2.1.1.1.3.2.5] Air CE AAW Energize Simulators / Stimulators Unit-1
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Weapons & CM Status / Requests Data
Output From: [2.1.1.1.3.2.2] Air CE AAW Actuate Weapons & Countermeasures Unit -1
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Sensor Operations Status / Requests Data
Output From: [2.1.1.1.3.2.3] Air CE AAW Operate Sensors Unit-1
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

[Diagram: 2.1.1.1.3.2] Air CE AAW Engage Implement Commands Unit-1

Arrow: Air CE AAW Unit-1 Platform Control Status / Requests Data
Output From: [2.1.1.1.3.2.4] Air CE AAW Control Platforms Unit-1
Input To: [2.1.1.1.3.2.1] Air CE AAW Set Equipment Unit-1

Done.

APPENDIX C

CE CONCEPTUAL ARCHITECTURE IMPLEMENTATION

By

Carl VanWyk
Naval Air Development Center

and

David Newport
Naval Weapons Center

TABLE OF CONTENTS

LIST OF FIGURES

Figure Number **Page**

LIST OF FIGURES (Con't)

Figure Number **Page**

Appendix A Figures

LIST OF TABLES

Table Number **Page**

1 CONVENTIONAL ENGAGEMENT

CE Functional Flow is derived from the fundamental AAW functions of Detect, Control, and Engage. In CE it is not so much that new functions are established, but that innovative new relationships are defined between these fundamental functions. If there is anything new in CE, it is that control must be established to ensure that these new relationships are established when required to conduct CE and that they persist through the duration of the CE.

Do not construe this to mean that CE will be simple or easy to achieve - it will not be. Just because the functions are similar, does not mean the CE architecture will be similar to that for conventional AAW. The difference will occur in the equipment performance enhancement required for CE over that needed for conventional AAW. Also, because new relationships among functions are defined for CE, new connectivity will also be required to support CE functional interrelationships. This part of the report develops those relationships.

In Figure C-1 the fundamental AAW functions are depicted in greater detail.

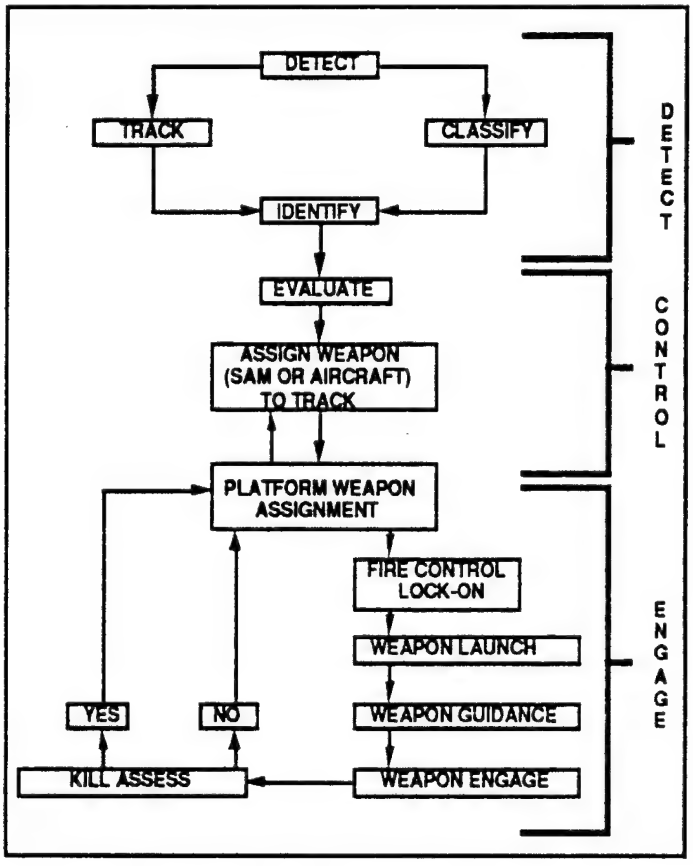


Figure C-1. AAW Functional Relationships

For Detect, sensors make repeated detections over time to develop positional information to develop contact tracks. Contact attributes such as platform type and specific platform characteristics are determined to distinguish the contact from others and to associate contacts with similar attributes. The collection of individual tracks and their associated attributes form a major part of the tactical picture.

The first major function of Control is to evaluate the tactical picture to make judgements concerning the intent of individual contacts, particularly those which have been categorized as hostile to the Force. This evaluation extends to ranking those with perceived hostile intent in the order of most threatening and to make preliminary matching of weapon systems both in position and over time to the threatening contacts. At the opportune time a hostile track is assigned for engagement to appropriate, capable weapons systems. As a practical matter, the assignment is made to the platform on which the weapons system is located.

In order to preserve weapon control to ensure that both Rules of Engagement are fulfilled and that efficiency of weapons employment is preserved, the Control function extends to the platform assigned engagement responsibility and through the engagement. This extension is performed by ensuring that the hostile track assigned for engagement is the specific track that the weapon is launched towards and guided to.

This is accomplished by ensuring that fire control sensors are locked on to the assigned track prior to weapon launch and that midcourse guidance commands to the in-flight weapon are developed from data obtained from those fire control sensors. Terminal guidance to the weapon requires hand over of the weapon's assigned track to those sensors which develop the terminal homing commands, whether the sensor be onboard the weapon or separated from the in-flight weapon.

Following weapon intercept, the weapon's controller assesses whether or not the weapon has killed the intended target. If not, the weapon platform continues engagement. If killed, or if further engagement by the assigned platform is not possible, the Force AAW Commander is notified so that further appropriate action may be taken.

This weapon/engagement control is simplified in the conventional AAW engagement as the sensors supporting the weapon launch and midcourse and terminal guidance are located aboard the weapon launch platform. In fact, the conventional AAW weapon system is designed to relate these sensors to the needs of the weapon for ensuring tracking continuity from weapon assignment through terminal homing.

2 COOPERATIVE ENGAGEMENT

2.1 CONVENTIONAL/COOPERATIVE ENGAGEMENT MODIFICATION

Now suppose that the sensors supporting weapon launch, midcourse guidance, and terminal homing are not located aboard the weapon launch platform, but instead the Force pool of sensor information is the basis for fire control acquisition, tracking and terminal guidance. This is illustrated in Figure C-2. When that occurs, Cooperative Engagement is said to be taking place. The following discussion will develop what functions must be performed to ensure that weapons may be effective when cooperatively employed.

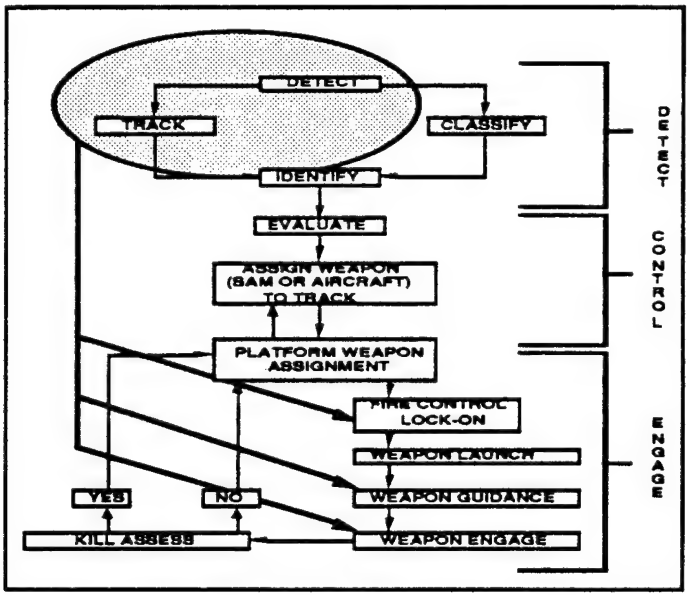


Figure C-2. Cooperative Engagement Functional Diagram

(Note that the weapon launch platform's sensors, in Figure A-2, may themselves contribute to the Force pool of sensor data. When weapon employment is based on only launch platform sensor data a conventional engagement takes place. Consequently, Cooperative Engagement spans all the intervening cases of no launch platform data being used to where only a part of the weapon employment cycle depends on off board data to where the entire engagement from launch to terminal homing depends upon offboard sensor data and processing.)

To engage a target successfully requires sufficiently accurate and precise targeting information to launch the weapon towards the target intended by the AAWC (or his designated authority). Following launch, the weapon may require an update of the target location in the form of either target coordinates or guidance commands to the weapon itself. As the weapon nears actual engagement, target position must be refined to the point that hand over into the terminal homing seeker's or sensor's/illuminator's detection volume successfully takes place. Then to have an effective engagement requires sensor detection and tracking data when needed to perform these functions of

fire control acquisition and tracking and terminal illumination/guidance. The term "fire control" is used here to make clear that the quality of sensor data and information must be sufficient to support the weapon engagement sequence. Consequently, there is an explicit relationship between required sensor information precision and timeliness and the weapon design and dynamics. This is generically illustrated in Figure C-3. At each stage of the engagement there are different demands for supporting sensor data quality.

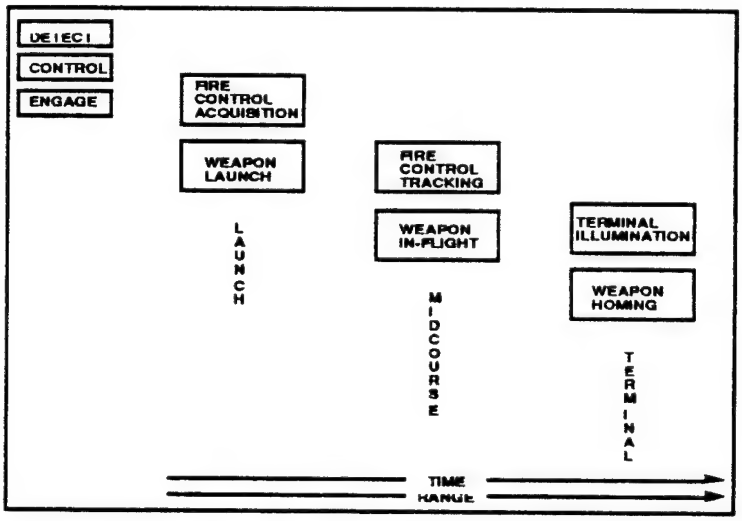


Figure C-3. AAW Functional Diagram

From a larger perspective of the AAW battle, there are two other criteria that should be satisfied in order to have an effective cooperative engagement. It is desirable that engagements take place at great range from defended points (such as Mission Essential units). The range line at the bottom in Figure A-3 is to illustrate that larger range translates into expanding the Force Battle Space. Just as important is that within that Battle Space engagements take place quickly so that as threats continue to close, multiple engagements of that threat may take place if needed, or another threat may be engaged before it closes in range. That is, increasing the Force Firepower (or engagement density in time and space).

It is fundamental in warfare that the employment of weapons be controlled. This is important from the standpoint of Rules of Engagement and from the tactical perspective of efficient use of weapons. During the engagement this control translates to ensuring that the weapon homes on the target intended by the AAWC (or other Warfare Commander).

During the conventional AAW engagement, the weapon system has been designed, engineered, built and installed to ensure this. Moreover, there are almost daily checks of the systems' ability to do this. Basically, this is accomplished by dedicating fire control sensors to supporting the individual engagement sequence and by placing those fire control sensors onboard the platform launching the weapon to ensure Fire Control data where and when needed. Consequently, there is not only a tight coupling of the required sensor

data to weapon's employment, there is also a clear understanding of who is responsible for ensuring that the engagement is of the intended target. Figure C-4 illustrates this by using arrows to indicate the continuity of control made possible by having only one platform involved in the engagement.

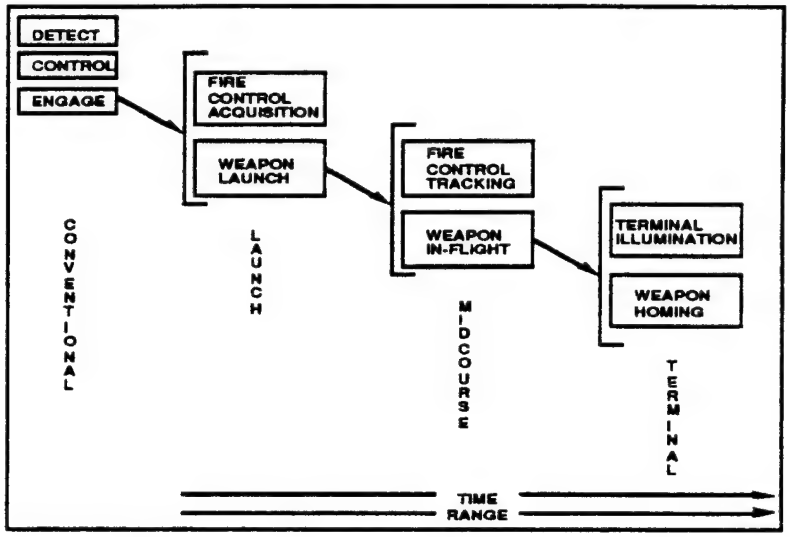


Figure C-4. Conventional AAW Functional Control

Reliance on sensors on board the weapon launch platform to support engagement imposes fundamental limits on Battle Space and Firepower. Engagement range is limited by the ability of fire control sensors on board the launch platform to detect, acquire and track the target. Engagement time is extended because while the fire control sensors are dedicated to support the launch and flight of an individual weapon they are not available to support other engagements.

But this need not be the case. IF the sensors supporting the fire control aspects of a specific weapon's employment can be separated from that weapon's launch platform, the sensors could be deployed to whatever range is needed to support the engagement time line. Using off board sensor data to support an engagement removes a major limitation on Battle Space extension (essentially leaving the weapon's kinematic and maneuver ranges as limiting on Battle Space). Also, IF the quality of the track resulting from correlation and fusion of Force sensor data is sufficient to support weapon's engagement, then the AAWC can assign tracks from that force track pool independent of the weapon launch platform's ability to track the target during the engagement. The target tracking continuity required for weapon engagement control results from orchestrating force sensor platforms. Being able to do this would permit an engagement rate independent of the launch platform's capabilities - a major Fire Power limitation (essentially leaving only the weapon launch rate as the launch platform's contribution to Fire Power limitations).

2.1.1 Cooperative Engagement Control

Figure C-5 introduces the geographic separation of the sensors supporting a weapon engagement from the weapon's launch platform. Limitations on Battle Space and Firepower are less stringent in this Cooperative Engagement.

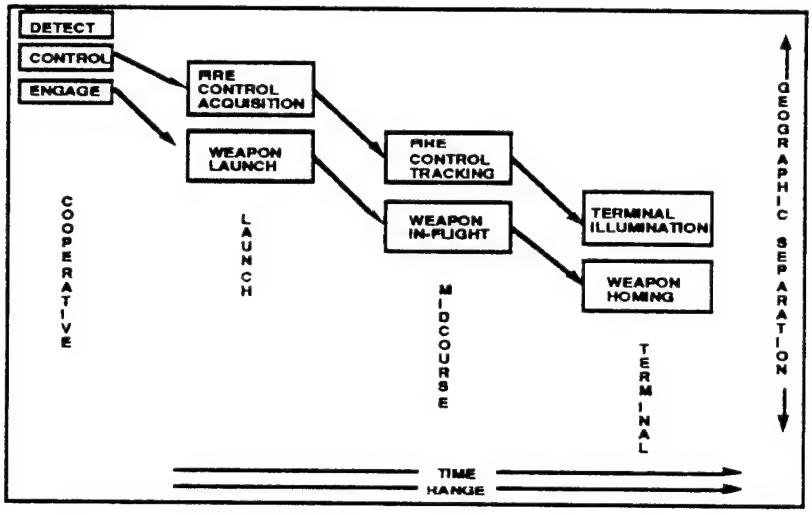


Figure C-5. Cooperative Engagement Control

Weapon control is accomplished as before by providing target location with sufficient accuracy and precision prior to launch to point the weapon toward the intended target. Weapon control continues by updating the target's and weapon's relative position through midcourse guidance commands and continuing through the transition to terminal homing. Force sensor data now provide the basis for weapon guidance.

But in doing that, weapon control responsibility has become diffuse. When the sensors supporting the engagement are not on the launch platform there can be loss of weapon control even though the pool of sensor data is of high enough quality to support the engagement. Because of the geographic separation, these separate platforms may lose the ability to communicate or for the sensor platform to even know that its sensor's continued focus on the target for the in-flight weapon is fundamental to weapon guidance control.

Also, because the sensor and weapon platforms are not locked together in the time frame defined by the weapon's engagement time line, there is the distinct possibility that the launch and guidance data may not be available when needed or at the rate dictated by weapon kinematics.

To illustrate the criticality of the time dimension, consider the following example. Suppose the assigned target is inbound at Mach 2 and the selected weapon has an average speed of Mach 4. Then the closing velocity between weapon and target is Mach 6 or about 1 NM per second. Then, if the range to predicted weapon intercept point is 100 NM from the launch platform, the sensor data on

which formulation of fire control midcourse commands would be based must be available for 100 seconds beginning at weapon launch. Moreover, if the terminal maneuvers for homing begin with the weapons seeker's detection of the target at, say, 10 NM, then the transition to terminal must begin within about 15 seconds of the predicted intercept time (lots of things would affect the actual number - seeker type, target reflectivity/emmissitivity, detection volumes, airframe time constant, etc.).

Since effective weapons control is based on providing the guidance instructions or data when and where needed, it seems too important to leave to an informal "gentlemen's agreement" that sensor data availability and quality can support weapon engagement.

2.1.2 Cooperative Engagement Control Methods

Depicted in Figure C-6 are the positive means by which a Cooperative Engagement can be controlled. Essentially, what is suggested is that there be a function of ensuring availability of sensor data of fire control quality where and when needed. As this "fire control" quality is dependent on the specific weapon being employed, the assignment for performance of this function should be done at the time of weapon selection. Also, since the individual demands of the weapon need coordination over time and geography, an overall Cooperative Control function is needed. This also serves to provide Engagement Control continuity from the AAWC's matching of weapons and targets and making assignments through target kill.

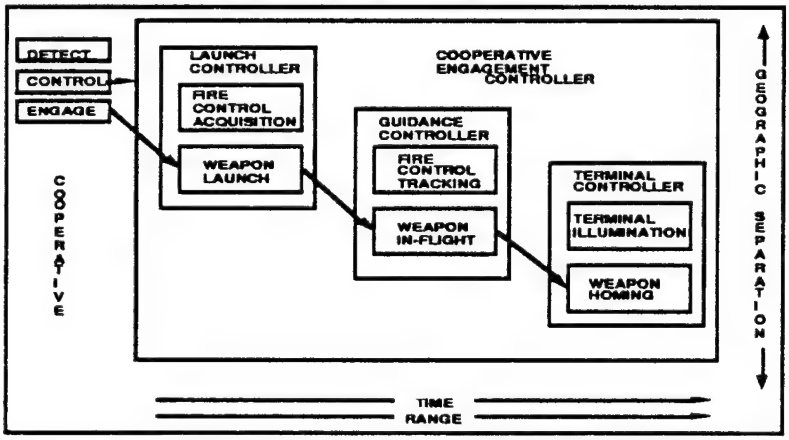


Figure C-6. Cooperative Engagement Control Methods

2.1.3 Observations

All of this certainly increases the complexity of conducting an engagement. By its very definition, Cooperative Engagement increases the number of platforms involved over that when conducted conventionally. Additionally, all it would take to decrease overall measures of effectiveness would be that there is just one additional event that is performed successfully with probability less than one.

There are threats now being fielded which will significantly reduce Battle Space and Firepower. For example, threats which fly low or have reduced signatures may not be detected until very late. Another means to delay engagement (and hence reduce Firepower) is to confuse the engagement picture with a mix of conventional and reduced observable platforms. Battle Space and Firepower are reduced when threat platforms fly very fast (limiting available time for engagement) and have reduced signatures (limiting Battle Space). At worst is when all are combined in the high speed, sea skimmer missile. Any one of these can cause a reduction in the number of engagement opportunities.

Cooperative Engagement can potentially buy back those lost engagement opportunities against threats such as those described above, increasing both Fire Power and Battle Space. This is illustrated in Figure C-7. The threat type is low altitude flying, RO cruise missile targeted against the closest ship. The E-2 makes an initial detection but without a weapon can not engage - a lost opportunity. Similarly, a fighter aircraft may have a fleeting detection but does not engage as its weapon is not suitable. Another lost opportunity and loss of additional engagement range (from the cruise missile's target). Finally, a surface platform detects the in-flight cruise missile but only in broadside and too late for it to engage, but in time to provide the targeted platform a heads up so that it may engage shortly after the cruise missile penetrates its sensor horizon. CE, IF in place, would have expanded the Battle Space, increased Fire Power, and provided for redundant engagement opportunities.

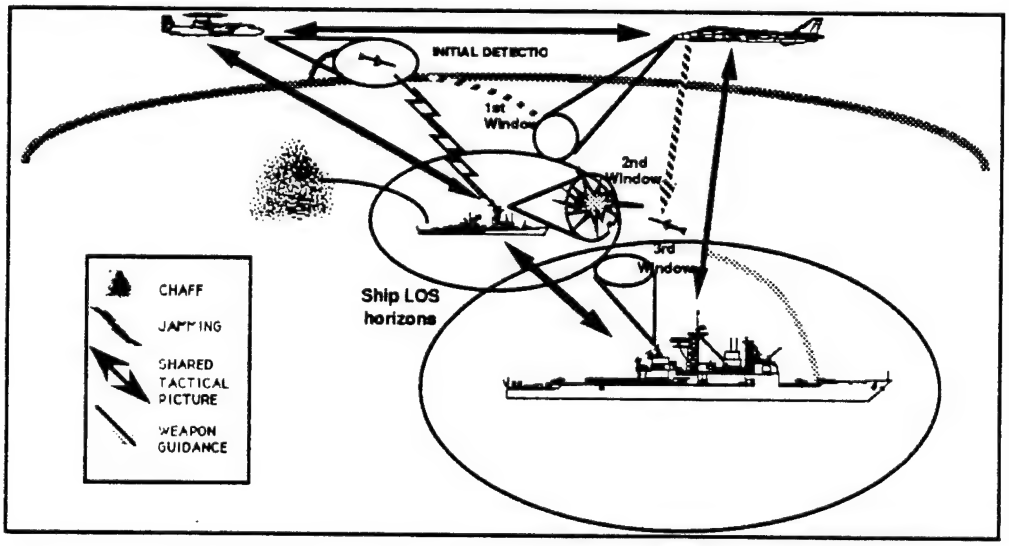


Figure C-7. Low, RO Cruise Missile Threat

There is another advantage to Cooperative Engagement. The weapon launch platform need not radiate high power RF to support the engagement, relying instead on other sensor platforms to develop the fire control quality sensor data and tracks. True, the weapon launch platform must radiate over communications links, but those can more easily be made covert. This also would deprive the adversary knowledge of which are engagement platforms as

sensor platforms and guidance platforms would be separate and not necessarily radiating engagement unique signals.

2.2 COOPERATIVE ENGAGEMENT FUNCTIONAL FLOW

Now, lets return to the development of the functional detail which would ensure that these fundamental principles of AAW are adhered to. That development has been done. But, because of the additional complexity of Cooperative Engagement, that functional flow is itself complex. Perhaps too complex for immediate presentation. Consequently, the following builds towards its introduction gradually.

The first step towards making something more intelligible is to set the reader or user at ease with the format of its presentation. One way to do that is to make the reading of the slide more natural, say as in reading. We start reading a page at the upper left hand corner and read to the lower right hand corner. So a "comfortable" presentation format is to place the more important ideas that are to be related in those two positions.

The idea we want to convey is that Cooperative Engagement is the use of the Force sensor data and track pool to directly support a weapon's homing to its intended target. Since the "Detect" must occur first, that is placed in the upper left hand corner. We want to end with the Weapon engagement or Homing, so that is placed in the lower right hand corner, as depicted in Figure C-8

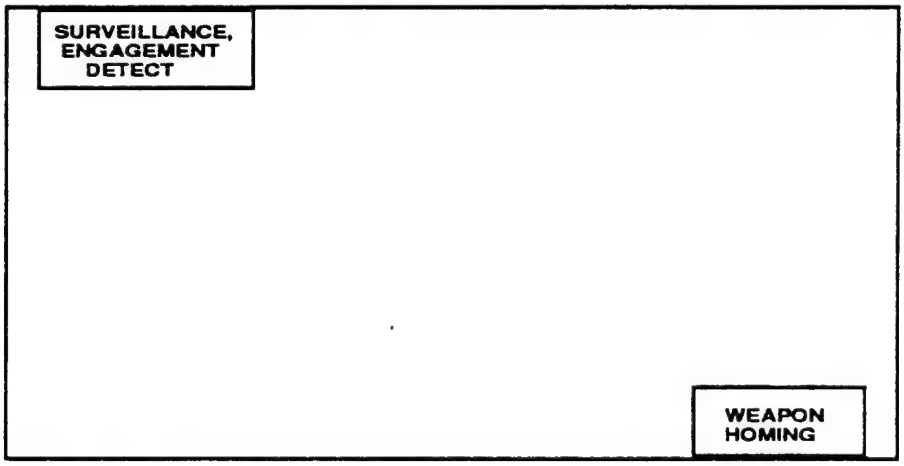


Figure C-8. Basic CE Functional Flow

The other major functions needed to ensure successfully progressing from Force Detect to Weapons Homing have been added in Figure A-9. Now it appears the other major functions have been haphazardly scattered around this page. But they haven't been. First, since we are ending with a weapon homing there is a natural sequence of weapon launch and in-flight guidance that must lead directly to that homing illustrated in the sequence on the right hand side.

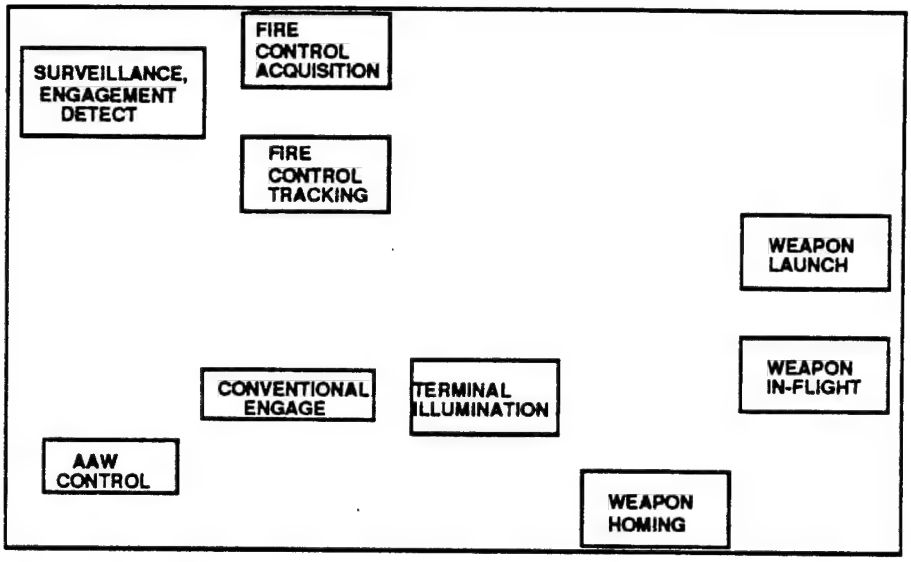


Figure C-9 Basic CE Functional Flow

Now we have stressed that Cooperative Engagement is reliance on the Force pool of sensor data for Fire control acquisition and tracking, with some modifications in sensor control or mode of operation. But the point is that there is only minimal dedication of sensors to Fire Control. Consequently, "Fire Control Acquisition" becomes largely processing of sensor data from the Force pool to form specialized tracks of sufficient quality to meet the chosen weapons launch and guidance requirements. This may mean holding sensors in contact or changing their modes of operation to increase data rate or precision, but largely this is processing of sensor data. "Fire Control Tracking" becomes providing contact update reports at a sufficiently high enough rate and quality to form the tracks whose precision meets weapon in-flight guidance requirements. Because these Fire Control functions are associated with the Force pool of sensor data, they have been placed in close association with where the "Detect" function is depicted.

The "Terminal Illumination" box has been placed in proximity to the weapon homing because of the intimate relationship that exists between the illuminating sensor and the weapon while in the terminal phase. The platform carrying the sensor must be positioned when the weapon requires the illumination so that the illuminating energy is reflected off the target with sufficient power for the weapon seeker to sense and identify its energy source. Also, the illumination may only be required for a short period of time and consequently scheduling becomes critical. Also, the illuminating platform may be transitioning from conventional engagements to support this Cooperative Engagement. All of these factors governed the placement of this box relative to the weapon homing and conventional engagement.

Finally, the overall AAW Coordination and Direction comes from the AAWC. It is his choice to employ conventional engagement processes or to decide that the more complex Cooperative Engagement process is necessary. His box (AAW Control) is placed as the recipient of the Force tracks contained in the Force

tactical picture developed from the Force sensor pool. There he performs the Threat Evaluation and Weapon Assignment which may lead to Cooperative Engagement.

Now lets put in the first level of coordination to ensure that sensor data processed into fire control information is available where and when needed. The polygons in Figure C-10 represent that functional coordination and control tying together.

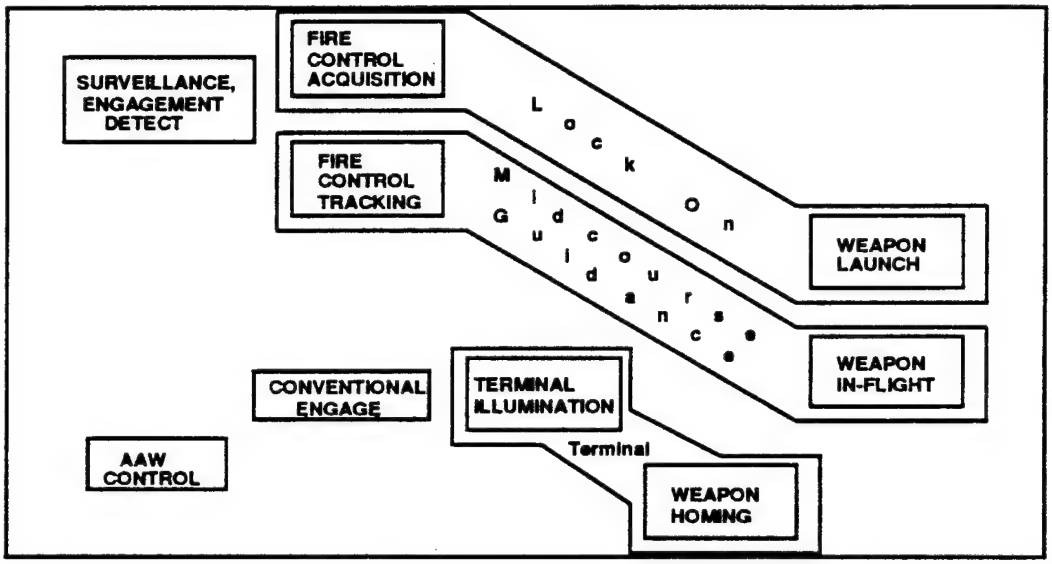


Figure C-10. Basic CE Functional Control Flow

Finally, in Figure C-11 let's box in the important functions which must be associated correctly in space and time to ensure a controlled Cooperative Engagement.

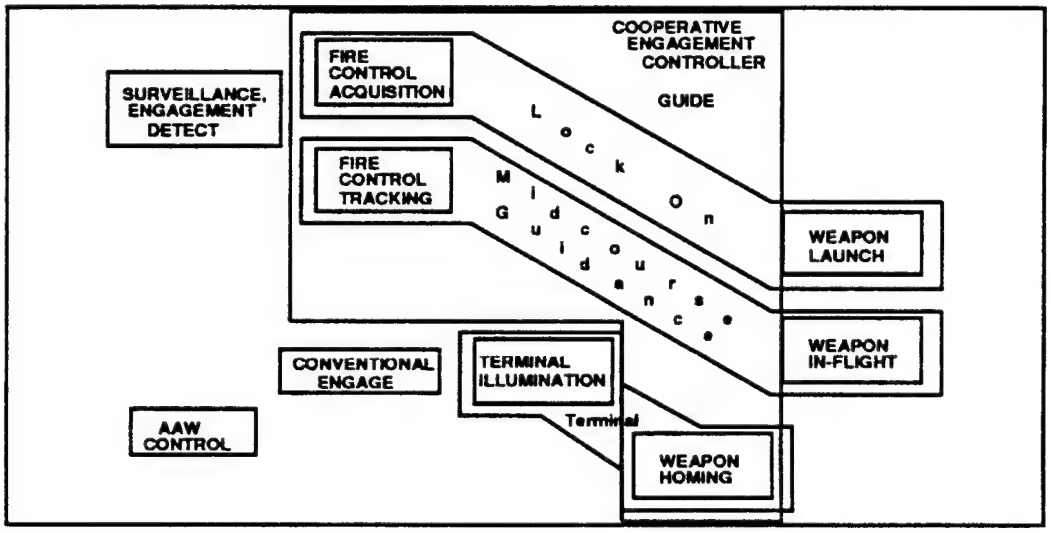


Figure C-11. CE Functional Flow Control

Stylistically what we have are these major groupings of functions. This now begins to resemble a formatted, finished diagram. These are the boxings which group the detailed CE functions in the functional flow developed for this Cooperative Engagement project. The major CE Functional Flow grouping is shown in Figure C-12.

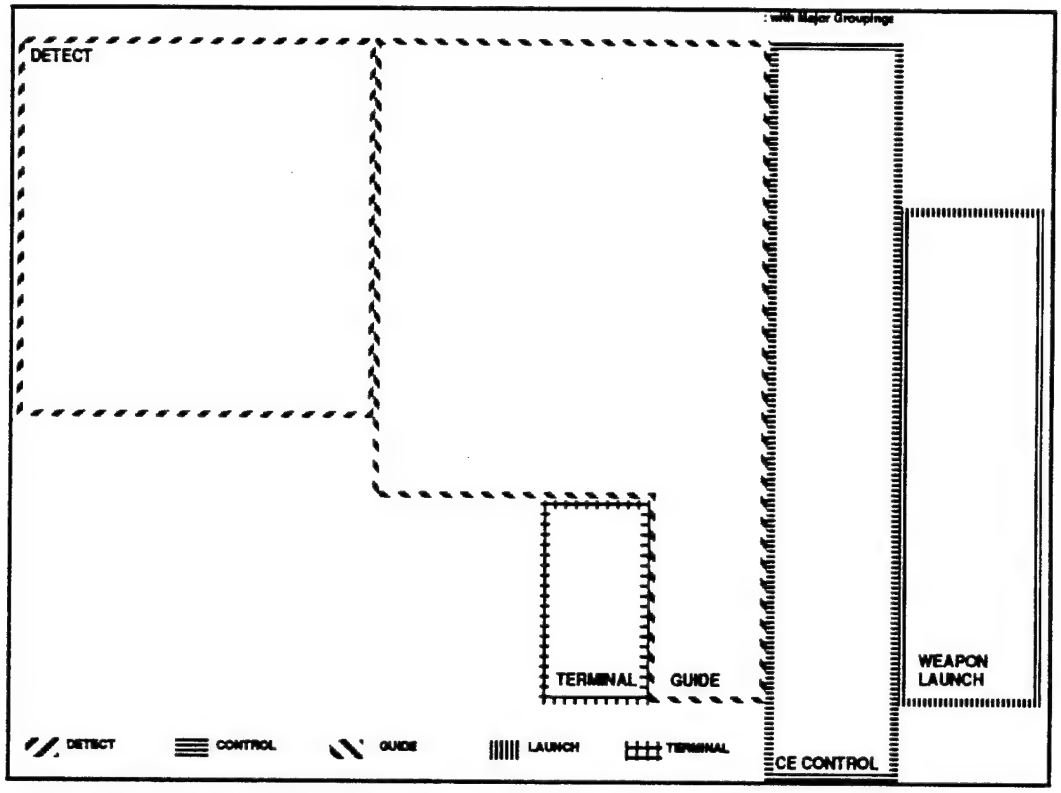


Figure C-12. Major CE Functional Grouping

Figure C-13 illustrates the depth of detail required in a logical functional flow for Cooperative Engagement. This functional flow has been built up from one developed for AAW. It was developed to complement for the Warfare Systems Architecture and Engineering (WSA&E) Current Plus architectures. As such it is not complete and must be used as an adjunct to the Conventional, Current Plus Architecture.

As has been previously suggested, this functional flow separates naturally into five major divisions: Detect, CE Control, Guide, Weapon Launch, and Terminal (Illuminate). This simplification was arrived at through grouping the CE AAW functions into sets where each set consisted of functions that are so intimately associated that they should probably not be separated (in the sense of assigning functions within one set to different platforms).

The Detect box includes those functions which are associated for the purpose of detecting and developing contact information and associating that information into tracks and a tactical picture. This can be for surveillance purposes or, at the direction of a CE controller, for directly supporting a cooperative engagement.

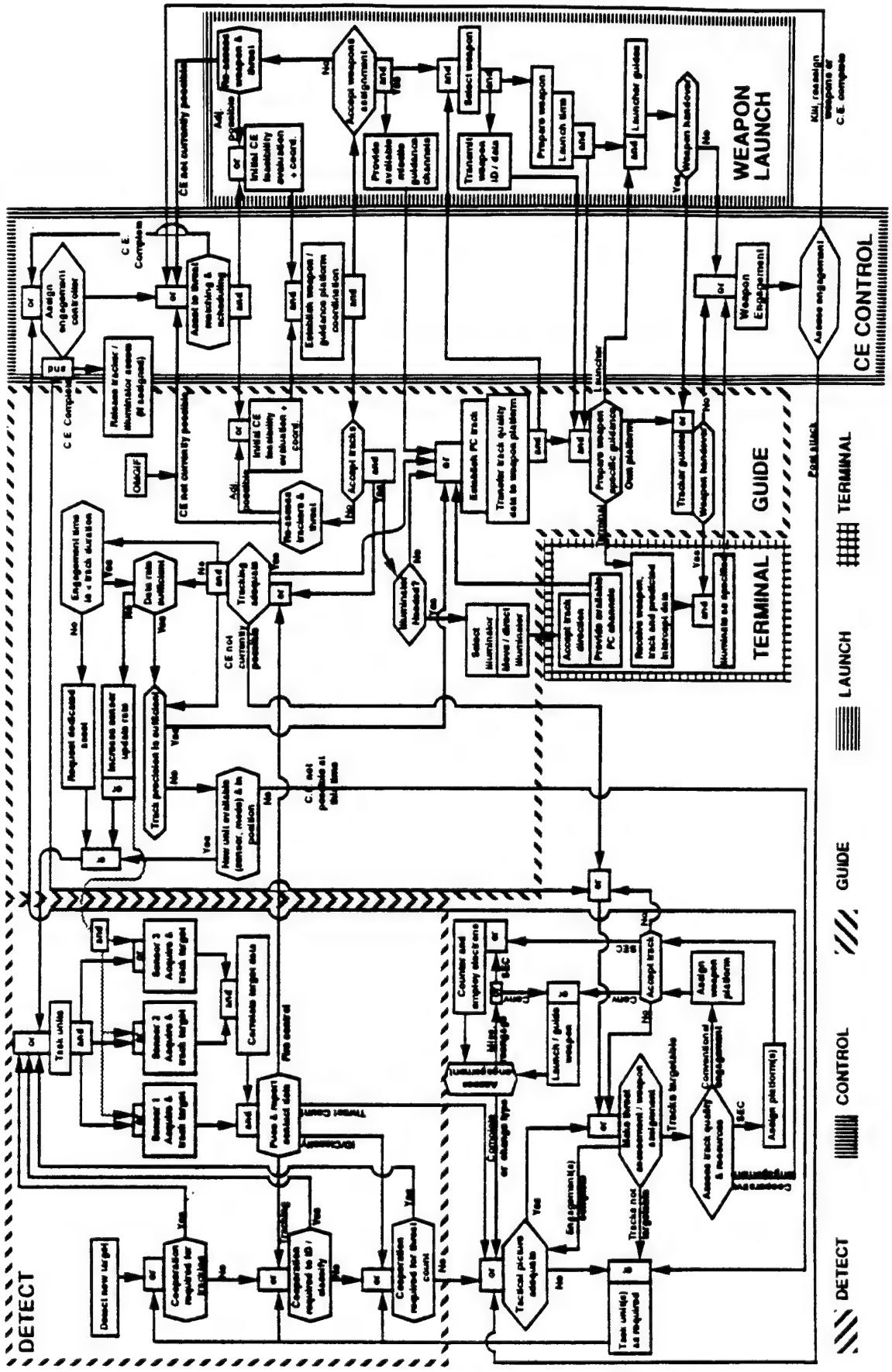


Figure C-13. Cooperative Engagement Functional Flow

In the unboxed area (Lower left corner) is where the WMA Commander (WMAC) functions of 1) provide direction; 2) maintain an adequate tactical picture; and 3) do threat evaluation and weapon assignment are performed. As part of weapon assignment here, the WMAC makes the determination whether or not cooperative engagement is preferable to conventional engagement. A rudimentary flow for conventional engagement and for coordinating EW with AAW is found in this area as well.

Should cooperative engagement be found preferable, CE control functions must be performed. It is a fundamental precept in developing this CE Architecture that an in-flight weapon never be out of control. The CE Controller is responsible for ensuring that overall CE control is maintained. The controller begins by selecting the platforms which will launch the weapon(s) and which will provide guidance. The controller's involvement continues to ensure that the assets needed maintain their contribution, that the coordination needed to assure an effective weapon launch takes place, and finally to assess the outcome of the CE. Should weapons be in-flight to a destroyed target, the controller has the additional responsibility to ensure that those weapons are either redirected to alternative targets or are destroyed.

Guidance functions are performed to ensure that the target track data quality is matched to the weapon's requirements for prelaunch, mid-course and terminal guidance. This involves deciding on where target track quality improvement is needed and working with sensor platforms to obtain the needed data. The Guidance platform formats and provides the fire control data to the launch platform and, if required, to the weapon following launch.

The Weapon Launch functions ensure that the right weapon is selected and prepared for launch, that weapon prelaunch required fire control data is available and inserted, and that CE participants are informed of weapon identification and of launch time. This platform may also receive weapon guidance data following launch for transfer to the weapon.

Should the weapon require support during the terminal homing phase of flight, the CE Controller and Guidance platform must ensure that this is provided. If this is in the form of Terminal Illumination (either by RF or laser, for example), the illuminating platform must be selected and moved to a point where illumination can be provided when required by the in-flight weapon.

This functional flow may be implemented in a variety of ways. According to our earlier definition of "Cooperative Engagement", there must always be at least two platforms, one to launch the weapon(s) and another to form and provide the fire control solution on which that weapon launch is based. Therefore, a Cooperative Engagement configuration may be made up with as few as two platforms to five (or more) platforms when each major functional category is performed on a separate platform. (The number may be in excess of five as more than one sensor platform may be involved in performing the Detect set of functions.)

Figure C-14 summarizes what we have just discussed: Cooperative Engagement is the use of Force sensor data and tracks to directly support the weapon engagement along that engagement's time line. The functions of Fire Control Acquisition and Tracking and Terminal Guidance would be performed using those Force level sensor data and tracks, rather than requiring that data to be provided by sensors on the weapon launch platform.

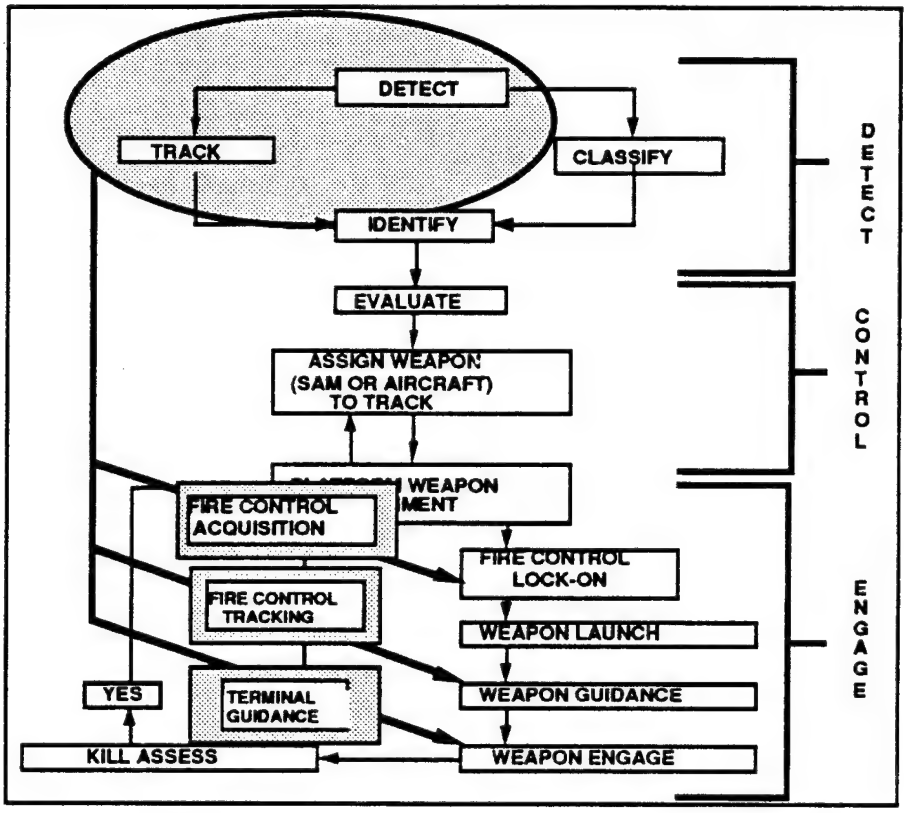


Figure C-14. Cooperative Engagement Overview

Conventional and Cooperative Engagement are simplistically contrasted in Figure C-15. In essence, the conventional AAW engagement relies on weapon launch platform sensors to provide the fire control data for launching and guiding a weapon. In Cooperative Engagement, the Fire Control functions are performed from off board the weapon launch platform. It may be that just the sensors are separated, but there is a multiplicity of platforms where as in the conventional engagement there is just one.

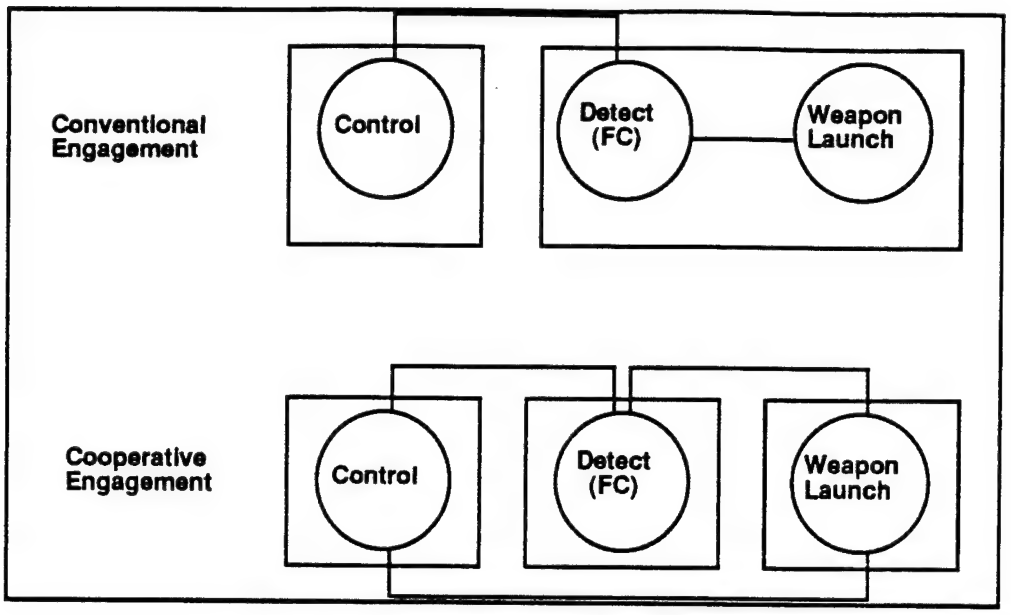


Figure C-15. Conventional/CE Contrast

This multiplicity of platforms and systems involved in Cooperative Engagement forms the physical part of the CE architecture. This physical aspect is developed in the next series of figures as various CE configurations are depicted. Following that, some of the CE configurations are selected according to which are "best" for combatting particular threat types.

3 COOPERATIVE ENGAGEMENT EXAMPLES

3.1 POTENTIAL COOPERATIVE ENGAGEMENT CONFIGURATIONS

Figure C-16 establishes the relationship between the nine (9) Cooperative Engagement configurations of platforms. As the list progresses from bottom to top, there is an increase in the complexity of the configuration. Also, there are two parallel paths, one for primarily surface platform involvement (with air support) and the other for air platform involvement (with surface support). The surface and air platforms become mutually involved to the same extent in this most complex case at the top, that of Ship and Air Forward Pass - the surface launched missile passing to air platforms for guidance and control.

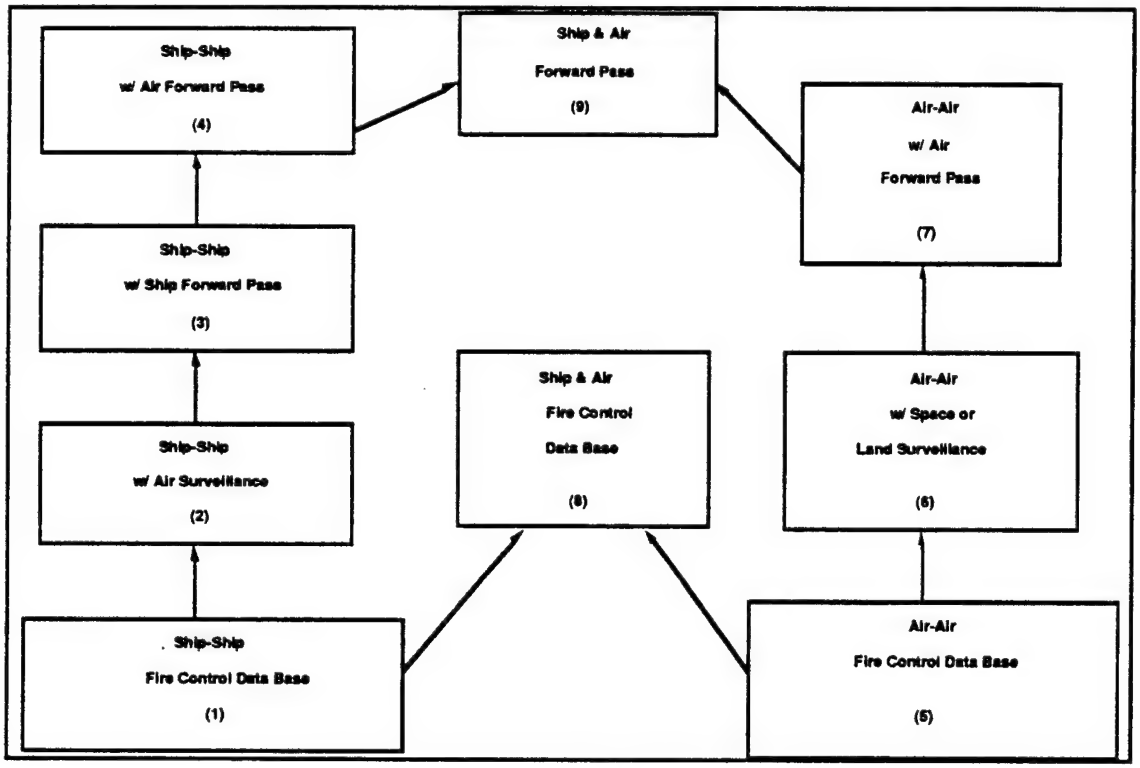


Figure C-16. Potential CE Configurations

In this next section a sample of these nine configurations illustrate the connectivity required to support performance of the functions as assigned to platforms. The introduction of connectivity and platforms introduces two of the other architectural elements: Physical and Connectivity. Later, the organizational elements needed to complete the CE Architecture will be developed. The full set of nine cases together with connectivity diagrams can be found in Annex A of this Appendix.

The Cooperative Engagement Case '0', Figure C-17, depicts the shading format for the major functions which are being performed aboard platforms.

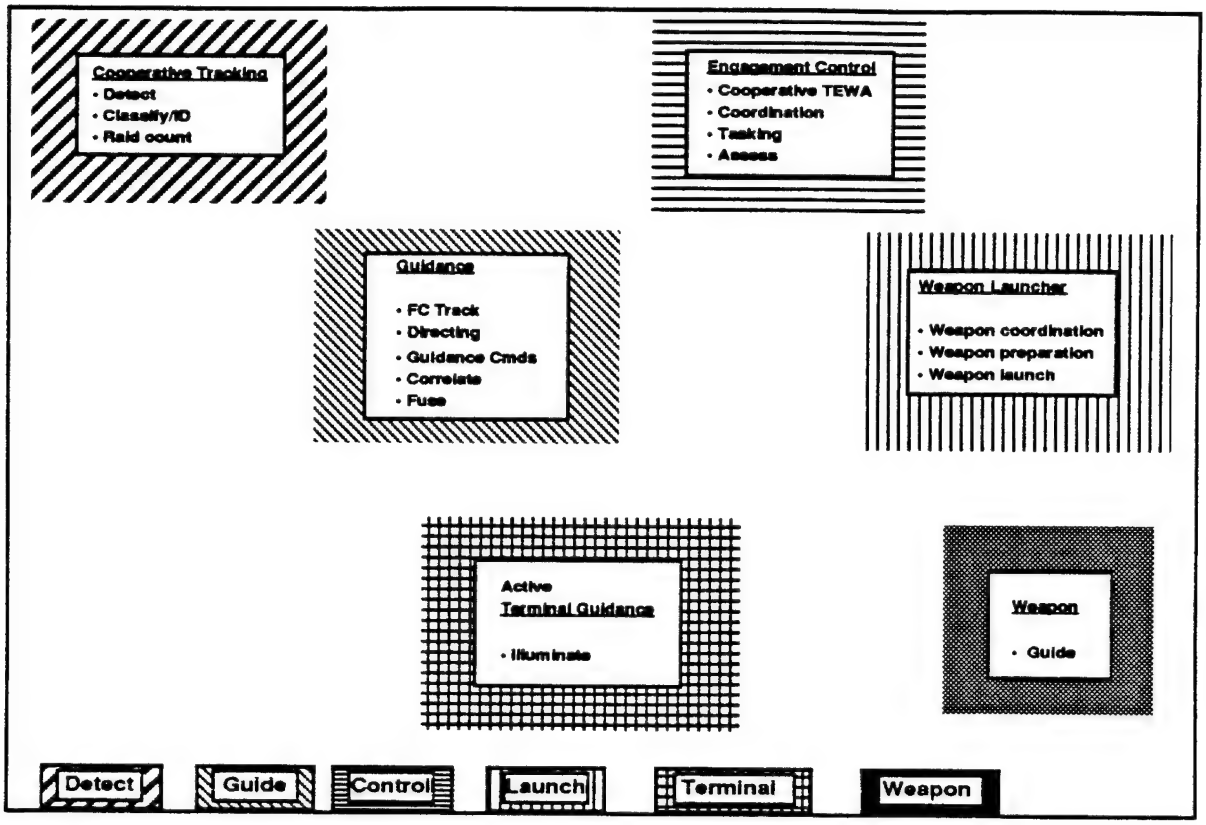


Figure C-17. Top-Level Cooperative Engagement Functions

The six primary CE functions are presented with the shading scheme carried over from the detailed Functional Flow contained in Figure C-13. The titles of primary subfunctions are also included in each box. For each of the diagrams which follow, the functional relationships and connectivity needed for CE is depicted. The nine cases place these functions on platforms in specific configurations with interconnections between platforms. Case '2' is presented as an example in Figure C-18 with the aircraft performing the Detect (Surv. Aug.) function and supplying data to a ship. The ship performs its guidance and control functions. This ship is also in two way contact (Shared Database) with the ship which launches and provides terminal illumination for the weapon.

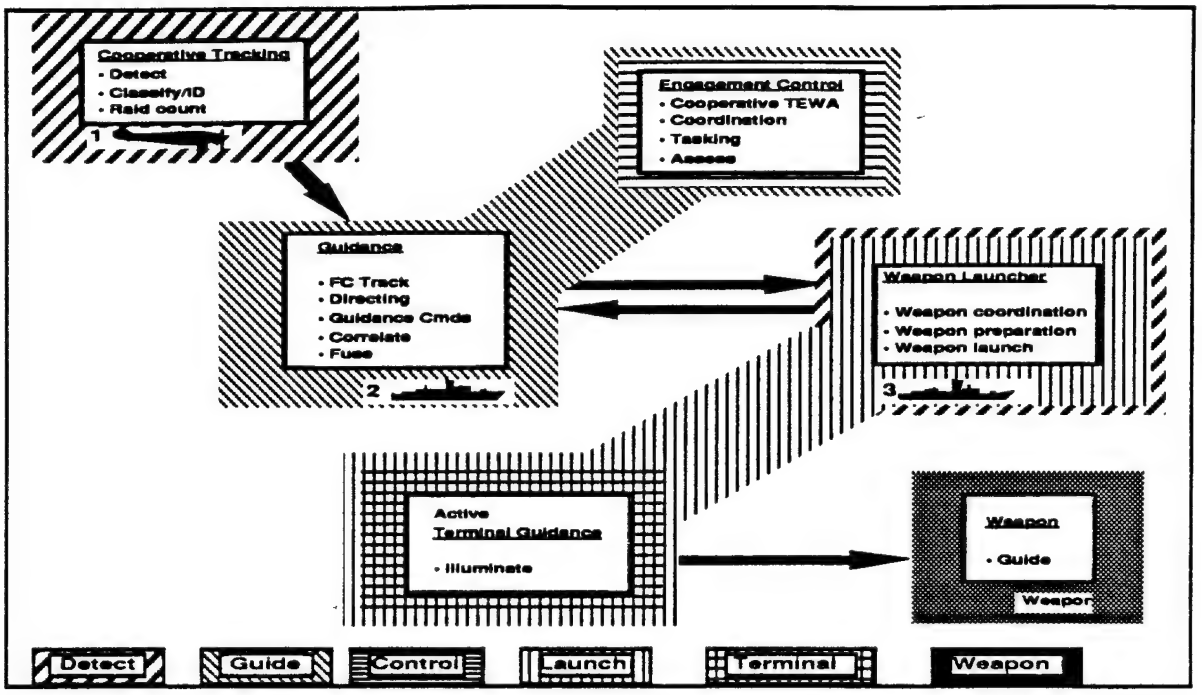


Figure C-18. Case 2: Ship Shared Database With Air Surveillance Augmentation

3.2 CE FUNCTIONS -- PLATFORM CASE COMPOSITE

Assembled in Figure C-19 are the nine CE configurations (Cases). Annex A to this appendix contains a larger version of each of these representations along with the graphic depiction of each case. While each is different, some similarities appear. The matrix with each Case (configuration) indicates which platform types are sharing a database, providing surveillance augmentation, or performing Forward Pass. There are parallel surface and air configurations. For example, Configurations 5 is just Configuration 1 but with air platforms instead of surface. The same is true for Configurations 2 and 6 as well as 4 and 7. Of these, the most complex is Configuration 9, the surface-to-air forward pass.

Given that all platforms are generally equipped for Cooperative Engagement, any of these configurations could be formed at any time by varying connectivity and by ensuring continuing asset involvement in the specific CE configuration while needed. The difficulty then becomes, which ones to form when? The answer is that it is the Commander's choice in response to the tactical situation.

The next section matches CE configurations with the four driving threat types introduced earlier. From that matching, the three configurations having the most potential contribution to countering a particular threat type were selected and are presented.

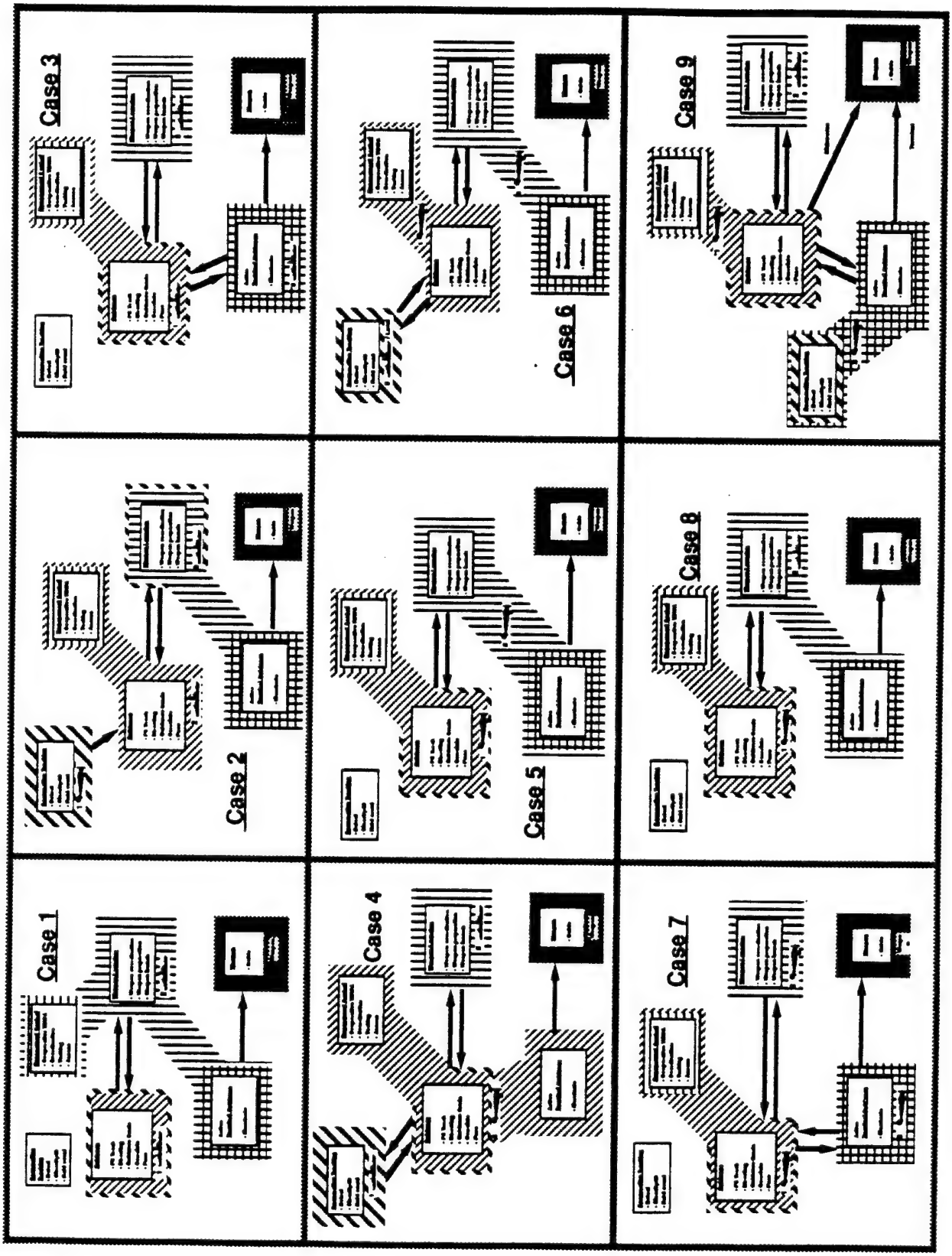


Figure C-19. Cooperative Engagement Configurations

3.3 COOPERATIVE ENGAGEMENT SCENARIO VERSES TACSIT

In the basic document, four Threat Types were described which would be particularly challenging for conventional AAW engagement, but which became easier when approached using Cooperative Engagement. The four Threat Types appear along the top of the matrix in Figure C-20. Along the side are listed the nine CE Configurations together with a tabular entry indicating the type of platforms doing what within a specific configuration.

	Detect	Guide	Launch	Termina	Control	Low, Slow, R.O.	OAB Conv,RO,Mix	High Flyer Fast	Sea Skimmer Fast
Case 1		S1	S2	S2	S2	N. A.	(R.O.?	+	N. A.
Case 2	A1	S1	S2	S2	S1	+	(R.O.?	+	+
Case 3	S1	S1	S2	S3	S1	+	Outer zone ships only	+	+
Case 4	S1	A1	S2	A1	A1	? (Ship detect?)	Outer zone ships only	+	? (Ship detect?)
Case 5	A1	A1	A2	A2	A1	+	Conv. only	+	+
Case 6	S1/ A3	A1	A2	A2	A1	+	+	+	+
Case 7	A1	A1	A2	A3	A1	+	+	+ (Marginal	+
Case 8	A1	A1	S1	S2	A1	+	Outer zone ships only	+	+
Case 9	A3	A1	S1	A2	A1	+	+	+	+

N. A. = Not Applicable
+ = Applicable

Figure C-20. CE Configuration Verses TACSIT

The entries in the matrix are a rough measure of the the relative usefulness of a particular CE Configuration when countering a particular Threat Type. Very conservative criteria were used before ruling out the utility of a particular CE Configuration for countering a particular Threat Type. For example, the lack of radar horizon extension with airborne platforms argues against seriously considering Configuration 1 against threats approaching at very low altitudes - especially when air surveillance is available as in Configuration 2. Consequently, Configuration 2 is preferable to Configuration 1 against this type of threat. Similarly, surface platforms probably would not play a major role in the Outer Air Battle (unless of course they are positioned at long range from the platforms they are defending).

It would be laborious (and not necessary) to pursue all nine Configurations for each Threat Type. What was done was to select the three Configurations which seemed to hold the most potential for countering each Threat Type. The selection criteria for the three were Depth of Fire, Fire Power, and Robustness (in the sense of graceful degradation). Together, the three could be said to then form a Cooperative Engagement Tactic for the particular Threat Type.

For each Threat Type, the CE Tactic physical relationship and connectivity are discussed.

3.4 COOPERATIVE ENGAGEMENT PHYSICAL ARCHITECTURE

Implicit in each platform diagram are the platform type, its sensors, C3 systems, and personnel. There is also, very importantly, an implied weapon type.

It must be noted here that this is as detailed as the Physical part of the CE Architecture will be. As indicated in the basic document introduction, ASNRDA has some specific CE Engineering Initiatives in mind. When those are available, the physical part of this architecture can be developed to the same level of detail as the functional.

3.4.1 Low, RO Cruise Missile Physical Structure

In Figure C-21 the three selected CE Configurations for the Low, RO Cruise Missile are arranged to illustrate the increasing Depth of Fire that would be possible when employing Cooperative Engagement.

The first, on the left, is Case 2 with the squares of the previous diagrams replaced with NTDS symbols to indicate the platform type performing the function. This case is essentially an air platform providing surveillance information to surface platforms who then orchestrate an engagement of the cruise missile at the radar horizon of the weapon launching platform (as that platform provides illumination to support weapon terminal homing).

In the next (or middle) engagement configuration (case 9), a surface platform launches a surface to air weapon which is provided mid-course guidance by the airborne surveillance platform and illumination for terminal guidance by yet another aircraft. Here, the engagement range from the surface platform is constrained only by the kinematic range of the surface-to-air missile - an extension that can be well beyond the horizon or detection capability of the surface platform.

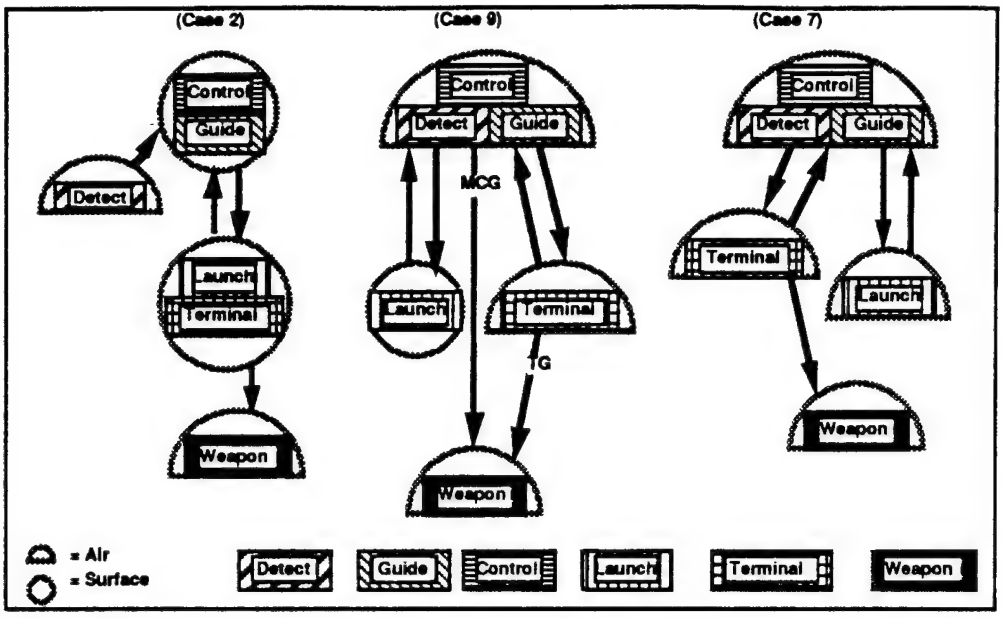


Figure C-21. Low, RO Physical Structure

In the last (case 7), the weapon is launched from a third air platform with illumination for terminal guidance provided by a separate air platform. Now, as long as the three aircraft can remain coordinated for this CE, the engagement range is independent of distance from any surface platform. This CE could take place anywhere desired, subject only to air platform availability.

The arrangement of platforms and assigned CE functions grouped by dashed line boxes in Figure C-22 suggests that there may be commonality of platforms between CE Configuration types. For example, in the first two, the same surface platform may launch weapons for both configurations. Or the same Airborne Early Warning platform may provide detection, guidance, and control for both of

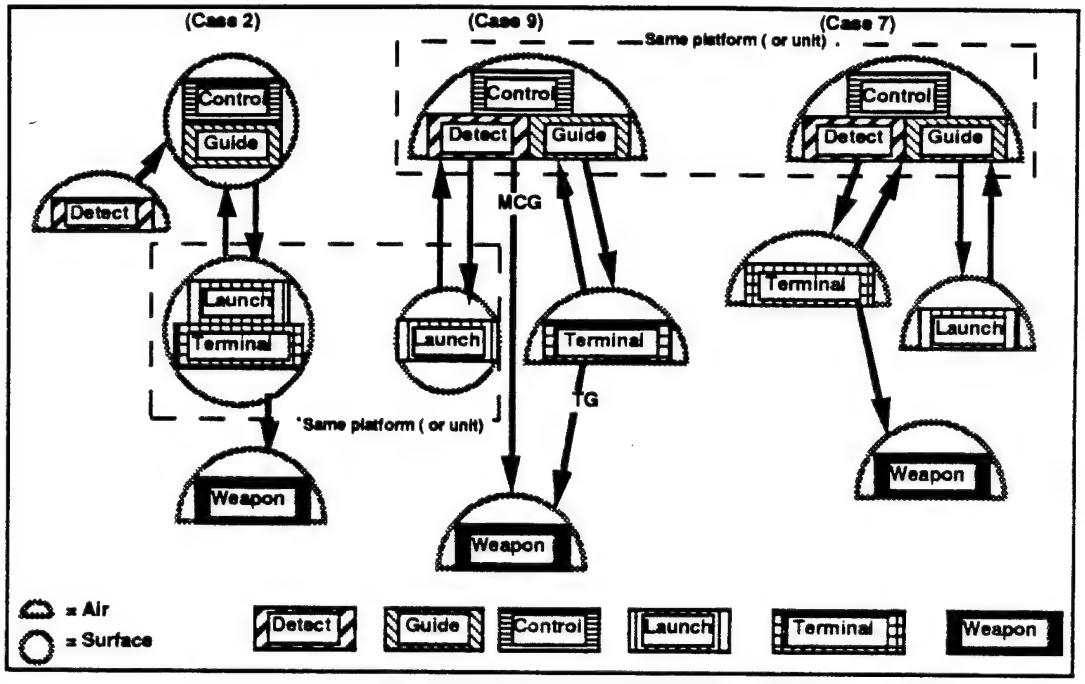


Figure C-22. CE Platform and Function Grouping

the last two configurations. Incidentally, that AEW platform might also be providing the "Detect" part of the first configuration. Physically, the actual CE platform configuration and number reduces to just the platforms depicted in Figure C-23 that represent the tactical situation illustrated back in Figure C-6.

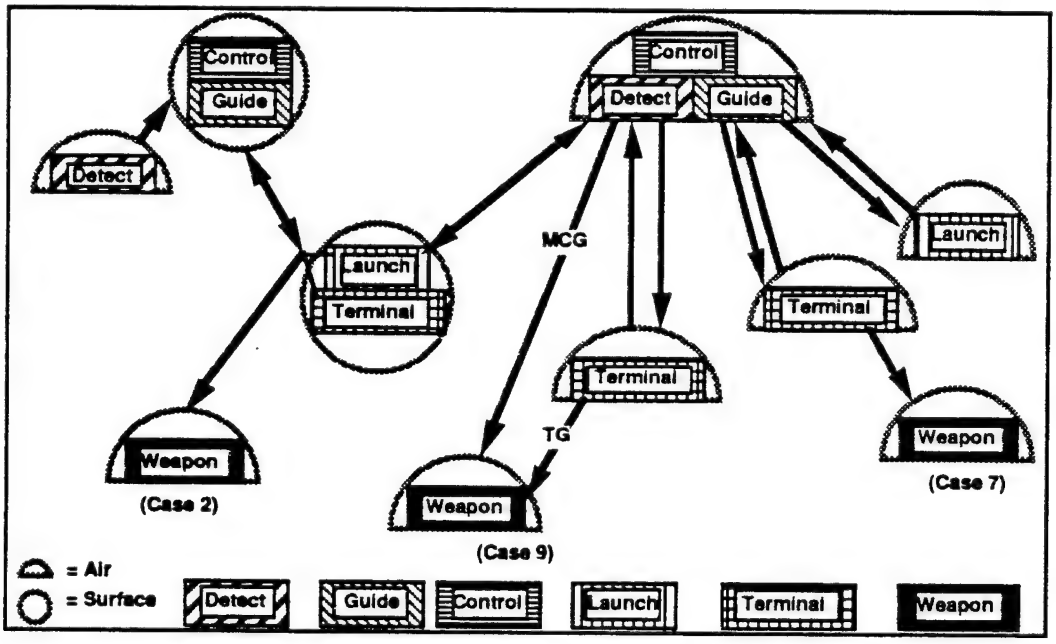


Figure C-23. CE Platform Functions and Arrangement

What this illustrates is the graceful degradation aspect of having multiple CE Configuration options available. As the possible engagement range collapses,

there is always another engagement option available until, finally, each platform may engage conventionally.

The other three Threat Examples have been similarly treated to develop a robust CE tactic for each that provides depth of fire and increased Battle Space. Those tactical configurations are illustrated in Figures C-24, C-25, and C-26.

3.4.2 OAB (Conventional, Low Observable Mix) Physical Structure

Figure C-24 shows how multiple cases could be employed to counter the OAB threat. In this tactic the potential engagement range reduces as the engagement proceeds from left to right.

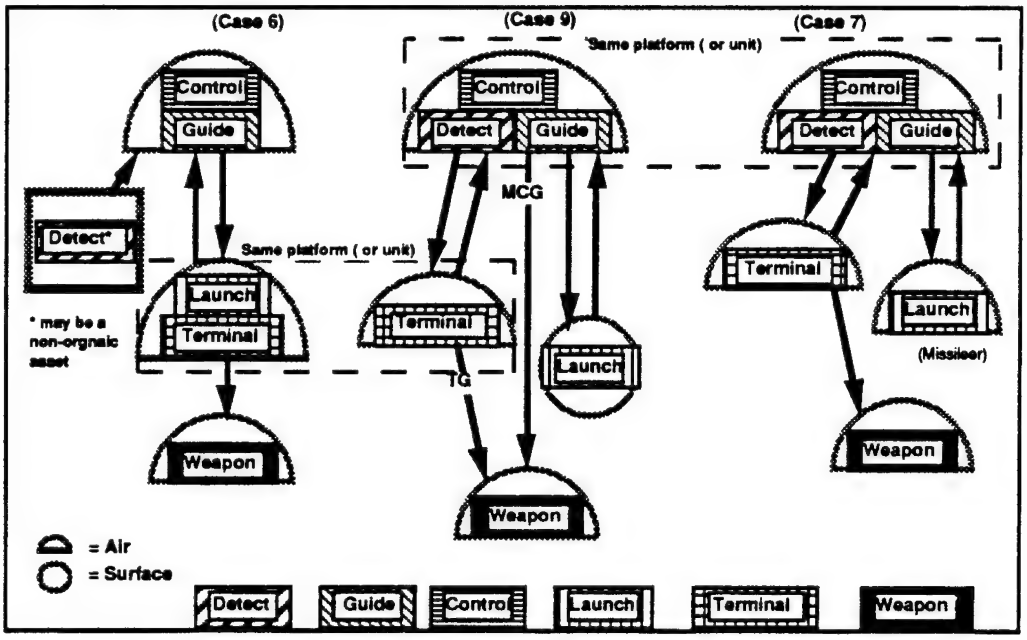


Figure C-24. OAB CE Physical Structure

In the first, a remote or non-organic Battle Force sensor system provides detection information to an air platform which processes the information into a launch fire control solution which is provided to another air platform which will launch a weapon based on that fire control solution. That weapon launch platform then continues to provide illumination for weapon terminal homing. Both of these air platforms are exchanging surveillance data which the first (top) air platform uses to build fire control solutions for use by other platforms in launching weapons. Those other weapon launch platforms might be surface as in the second type or another aircraft as in the last. These weapon launch platforms might well be just missile "barges" or aircraft.

As in the first threat type, the same platform can be involved in more than one CE Configuration. In this case, the launching aircraft in the first configuration could become the illuminator aircraft in the second configuration, after exhausting its supply of weapons, or even, perhaps, in the third. Certainly, the

aircraft providing control and guidance could be common to more than one of these configurations.

3.4.3 Fast, High Flyer Physical Structure

In Figure C-25, the first CE configuration (Case 4) against the Fast, High Flyer; sensors on the periphery of the Battle Force provide cueing detections to an aircraft positioned to accept (and itself detect) sensor information. That aircraft forms the data into fire control tracks which surface platforms will use to base launch of countering weapons. As the target intercepts are taking place beyond the horizon of the launching platform, weapon mid-course and terminal guidance is provided by the air platform. This configuration obtains the best intercept range because of the horizon extension with air platforms.

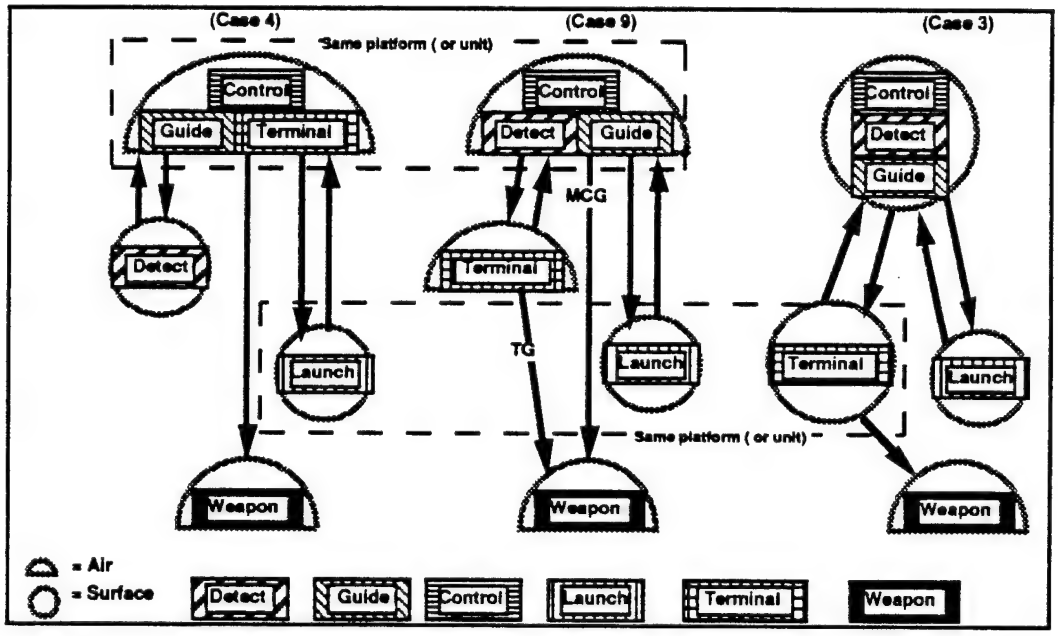


Figure C-25. Fast, High Flyer Physical Structure

The second configuration (Case 9) is much like the first with two exceptions. First the air control platform is using on-board sensors to establish fire control track, and second, is vectoring a second aircraft into position to provide precise terminal guidance, perhaps illumination, when required by the weapon. While in-flight to that point, the Control air platform provides mid-course guidance commands to the weapon to ensure that the weapon's terminal guidance requirements are met. This configuration provides an excellent transition from the OAB to the Inner Air Battle but, the terminal illuminator aircraft is vulnerable while in the SAM killing zone.

The third configuration (Case 3) relies on just surface platforms to extend the potential intercept range out to the kinematic range of the surface-to-air missile. This configuration would be best after clearing the SAM killing zone of aircraft (to prevent Blue on Blue kills). This is perhaps the most robust of the three.

In all of these, the weapon launch platform is not involved in developing or providing weapon guidance beyond the initial guidance inserted prior to launch. As such, that platform may be a large Battle Force magazine for missiles that are optimized for this type of stressing engagement. As in the first two, the set of configurations provides Depth of Fire, Firepower and Graceful Degradation

3.4.4 Fast Sea Skimmer Physical Structure

Figure C-26 illustrates the use of Cases 9, 8 and 2 to counter the Fast Sea Skimmer. The first configuration extends the engagement range out to the kinematic limits of the surface launched missile. As the residual threat missiles continue to close, the air platform provides fire control solutions on which to base surface launch of the weapon for intercept at the horizon of the launching platform. Alternatively, the airborne detections may be provided to a surface gateway entry point into a surveillance and control net involving just surface platforms. Eventually, the surface platforms would have to revert to conventional engagement using only data derived from on-board sensors.

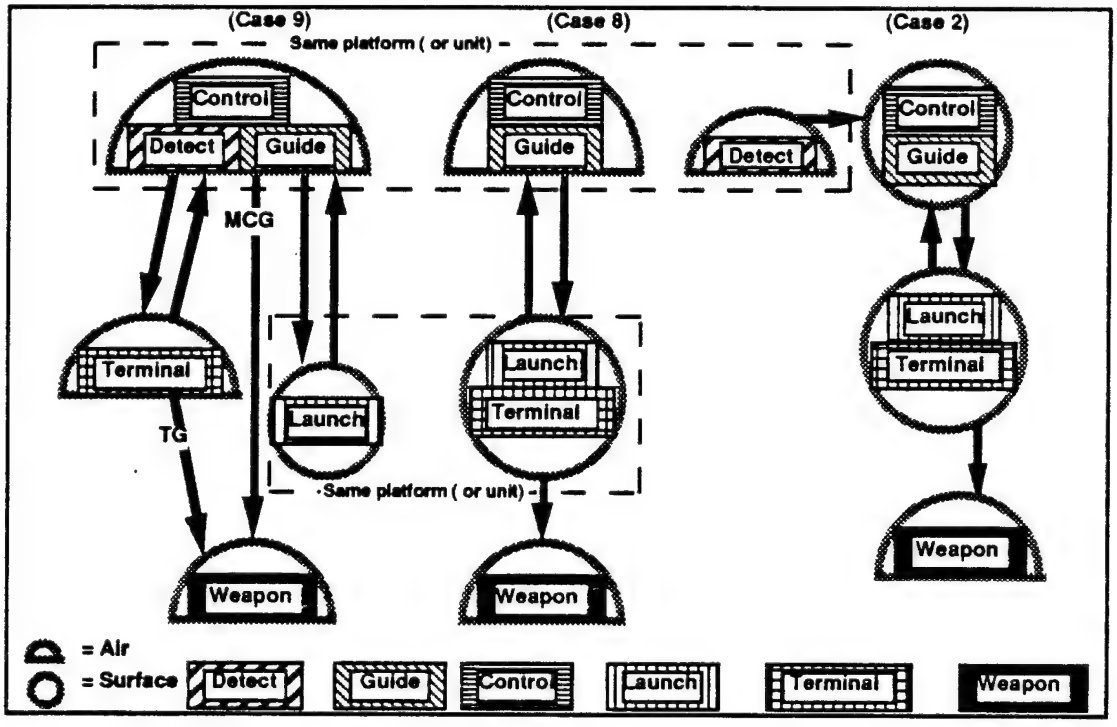


Figure C-26. Fast Sea Skimmer CE Physical Structure

The preceding slides have graphically illustrated the types of CE Configurations that are appropriate to each of four Threat Types. Earlier it was suggested that the collection of three configurations could be considered a CE Tactic for those types of threats. This is particularly true when considering that although there are three separate configurations presented, each in reality might be configured as one based on platform commonality.

The four following Figures (C-27, 28, 29, and 30) illustrate that commonality by tieing the three CE Configurations for each Threat Type into one composite Configuration centered around common Control units.

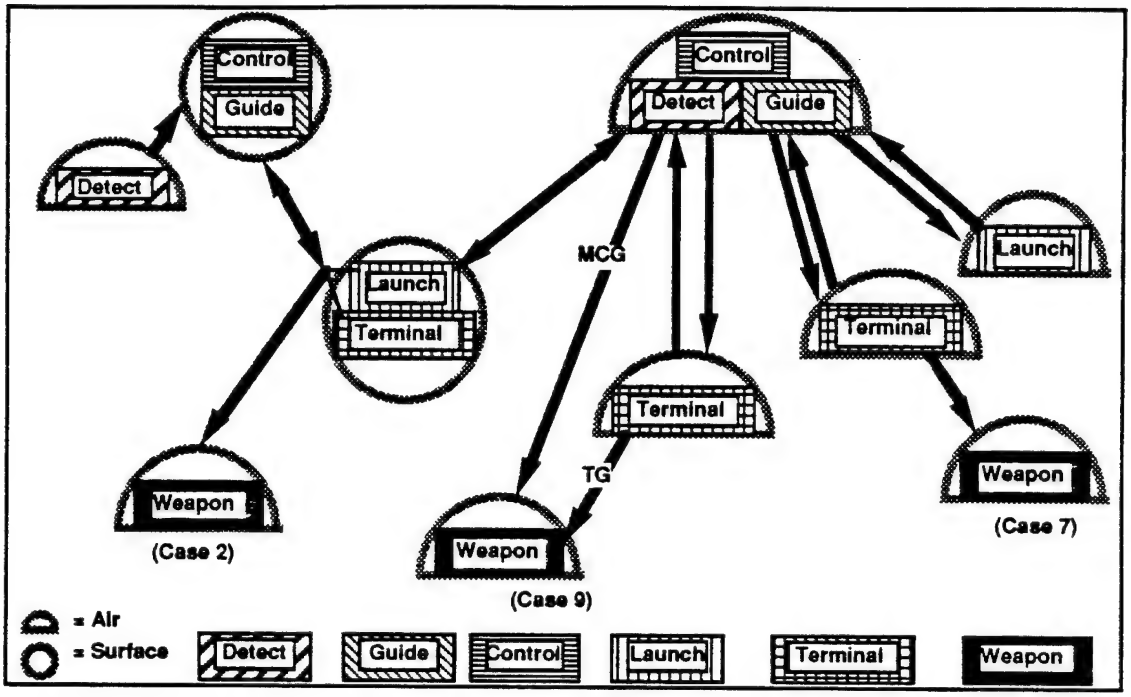


Figure C-27. Low, Slow, RO CE Physical Structure Control

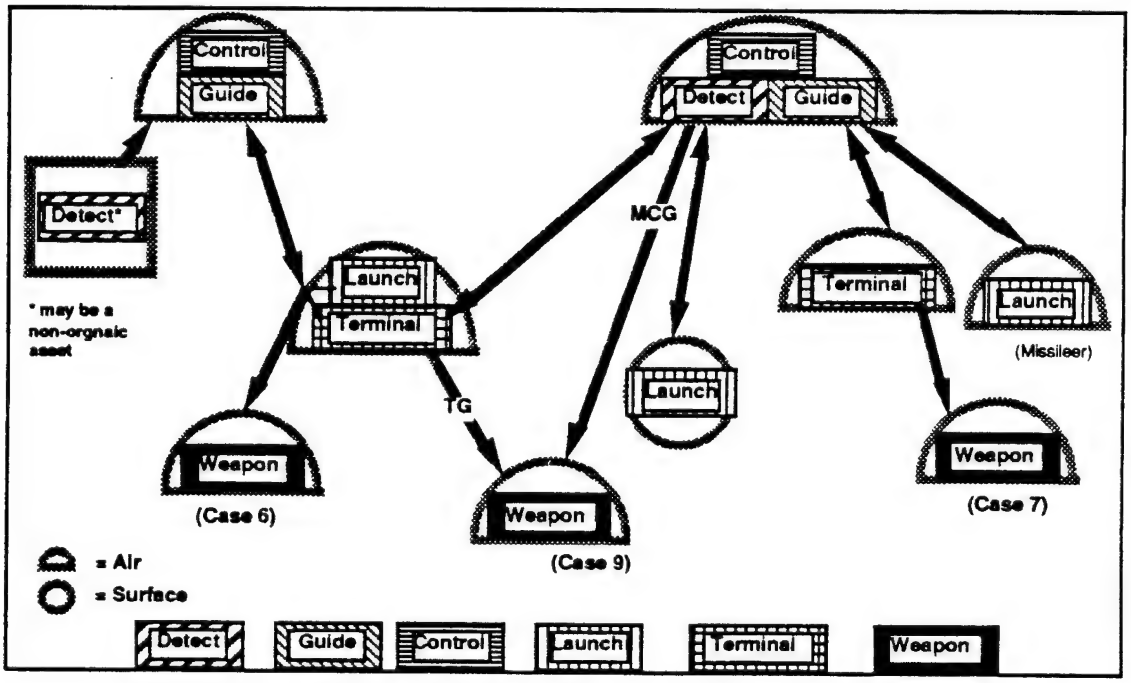


Figure C-28. OAB CE Physical Structure Control

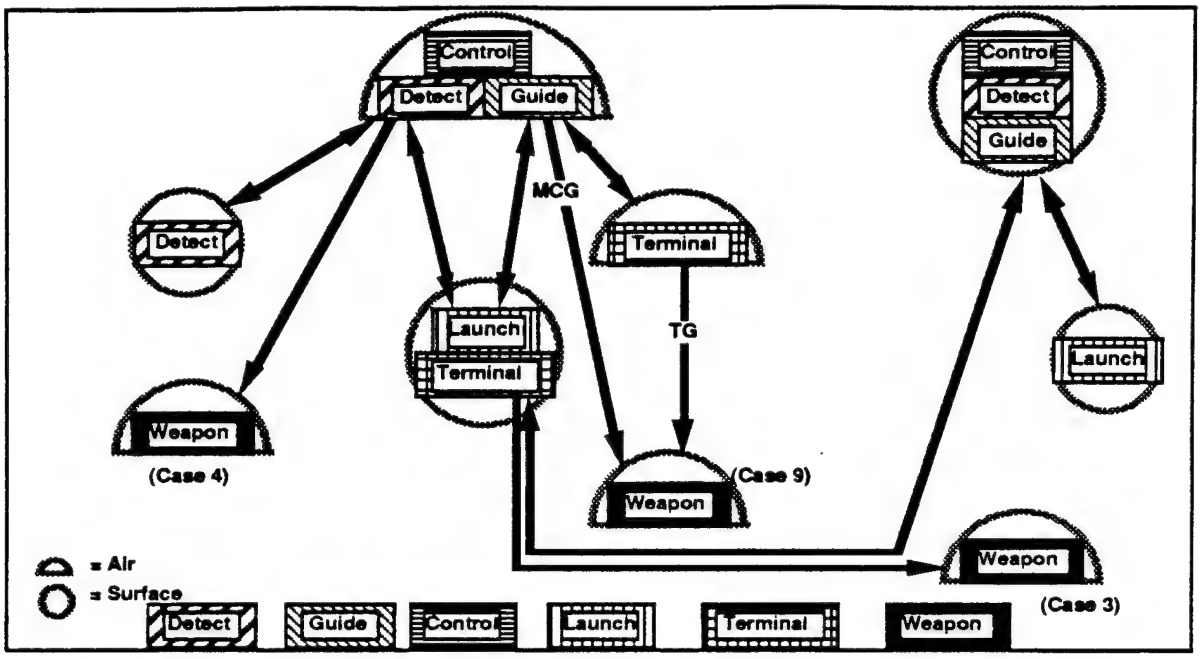


Figure C-29. Fast, High Flyer Physical Structure Control

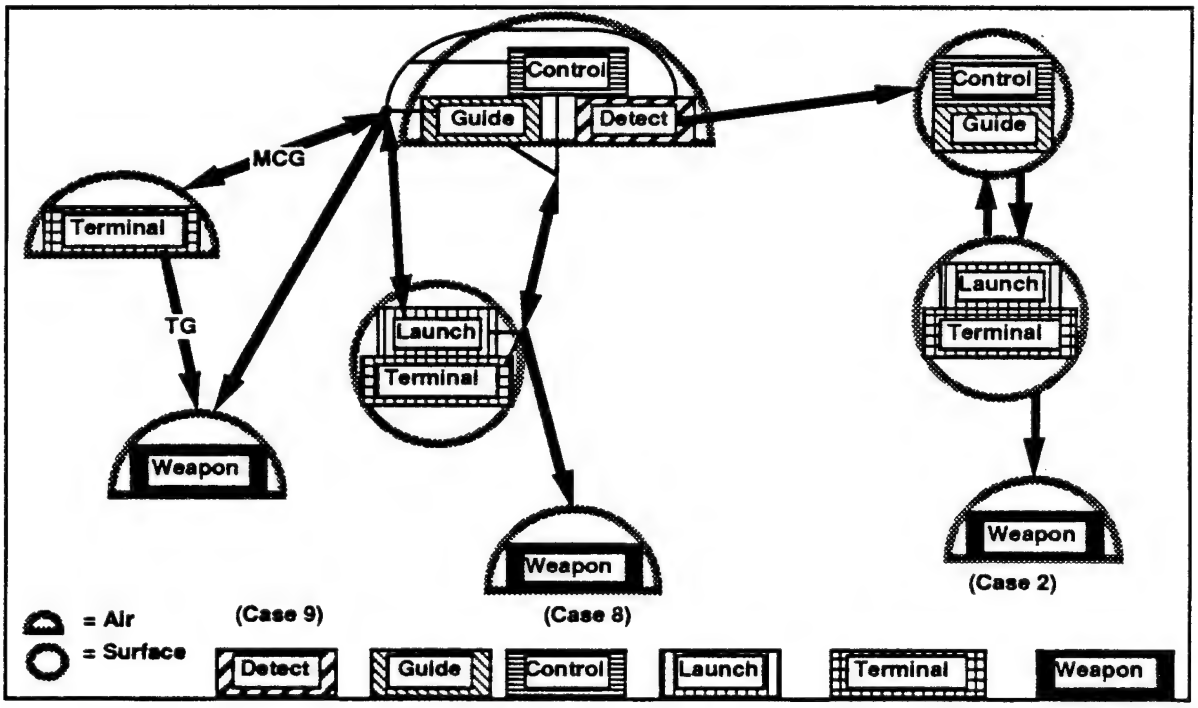


Figure C-30. Fast Sea Skimmer Physical Structure Control

This serves to not only illustrate the effect of platform commonality, but also the place of transitions between involved platforms, as launch platforms change from air to surface and terminal guidance platforms phase in and out of the sequence of cooperative engagements made possible by flexible CE configurations.

3.6 ORGANIZATIONAL CHART

In the preceding figures there is an implied need for coordination and control of Cooperative Engagement tactics to counter each of the four example threat types. In each, a set of three configurations provided depth of fire, firepower, and a means to gracefully degrade in terms of potential engagement range. But achieving those would require orchestration of assets - in availability, in positioning, and in time - to ensure the CEs would be conducted as intended. Also, these assets would always be in transition, either between CE targets or between CE and conventional engagements. An important function that needs performing before those transitions take place, is assessing the outcome of the CE to determine if assets can be released to take part in another engagement or if they must be held in contact to continue the CE using, for example, CE missiles in-flight to a just killed target.

All of these imply the need for CE Control. There are a variety of ways to structure an organization to explicitly provide needed control. Figure C-31 depicts a Cooperative Engagement Controller who is responsible for holding together and coordinating the activity of those units involved in a particular CE. There might be more than one CE Controller depending on the specific organizational structure chosen.

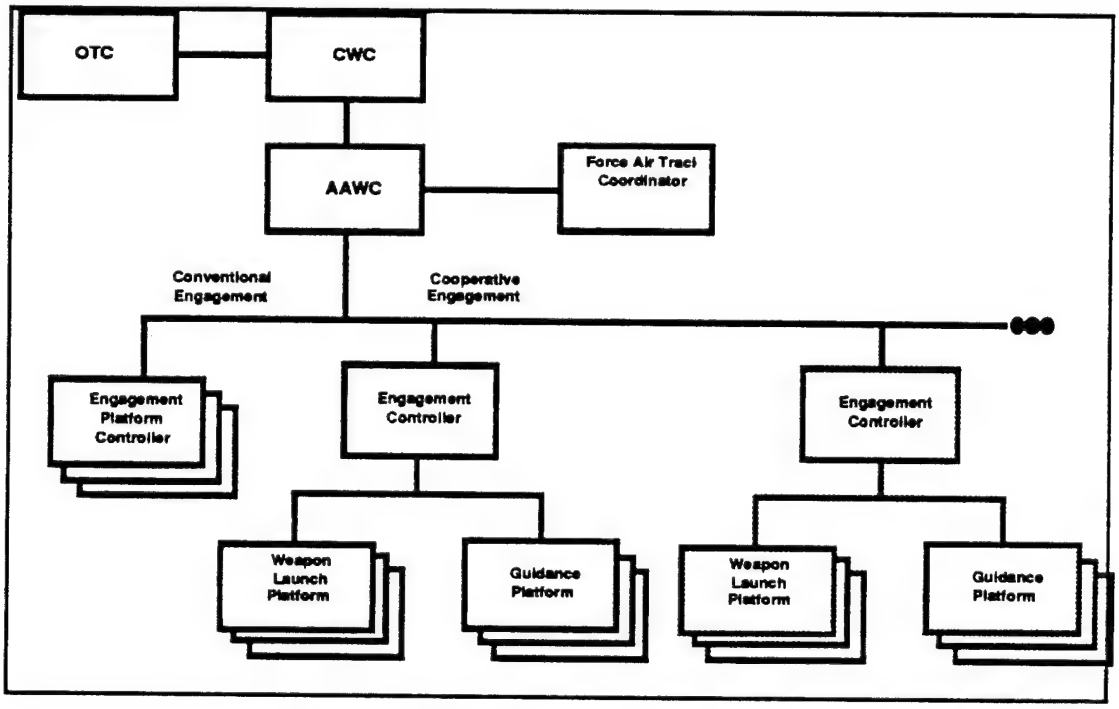


Figure C-31. Organizational Chart

One way to organize a structure is by Threat Type; another is by Geographic Area. The choice can not be made *a priori*. The choice must be made at the time the threat situation is known and planned, as there are strong reasons to

prefer one over another. For this discussion, two will be used as examples: CE Organization by Threat Type, and CE Organization by Geography.

The implication for CE Architecture development is to provide a physical structure (including connectivity) which can readily accommodate to the Command Organization chosen in response to the anticipated situation.

Figure C-32 contains an AAW Organization structure in which three principal AAW Battle types are considered: Air Weapon Launch platforms - OAB, Anti-Ship Missiles in-flight - Inner Air Battle, and those where Cooperative Engagement is a preferred means of engaging.

Those threats where CE is preferred have been further categorized into the threat examples presented earlier. The reasons for doing this are that CE structured by threat type has the significant advantages of common threat signature and flight profile within a type. This permits the use of common sensors and weapon types within, what may be, a constrained threat presentation region(s). Just as importantly, the threat may present itself in a rhythmic pattern permitting the CE application of assets and weapons in what should be a more efficient and less stressing manner. On the other hand, the major drawback is that the CE may occur anywhere in the Battle Force area of concern so that breadth of control and asset availability may be stressed.

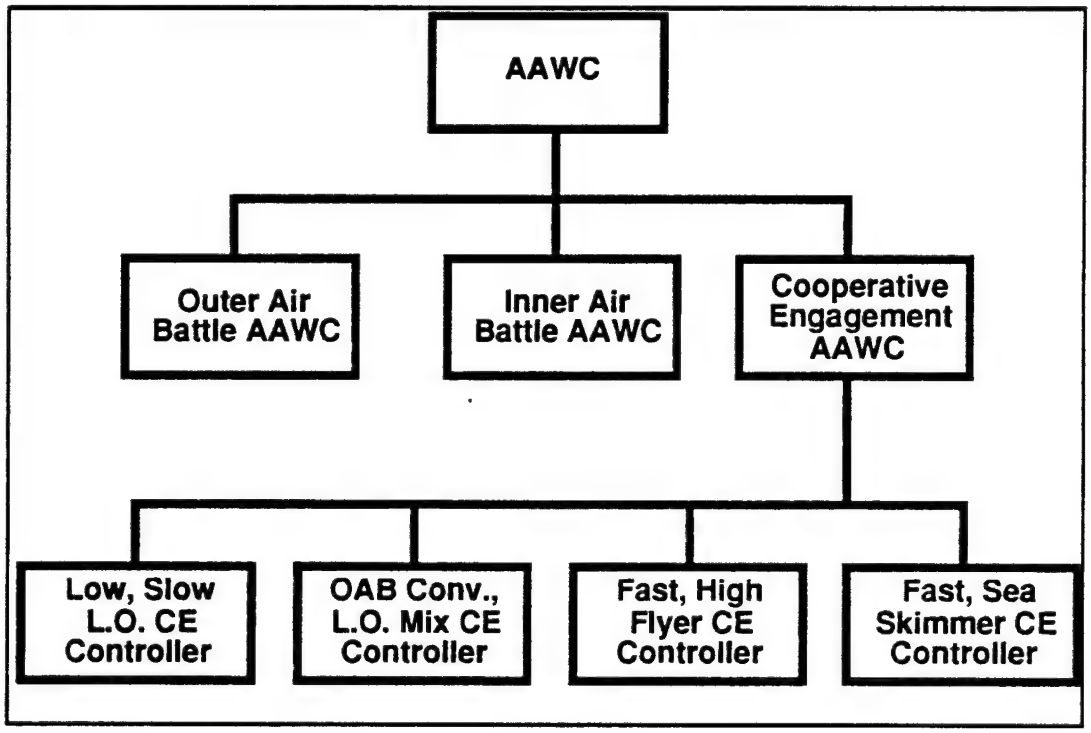


Figure C-32. Threat Based CE Organization

Figure C-33 graphically illustrates a Cooperative Engagement Organization based on Threat Type. Not only does the AAWC have to have control over the entire Battle Force, but so does anyone of the sub-CE Controllers for each.

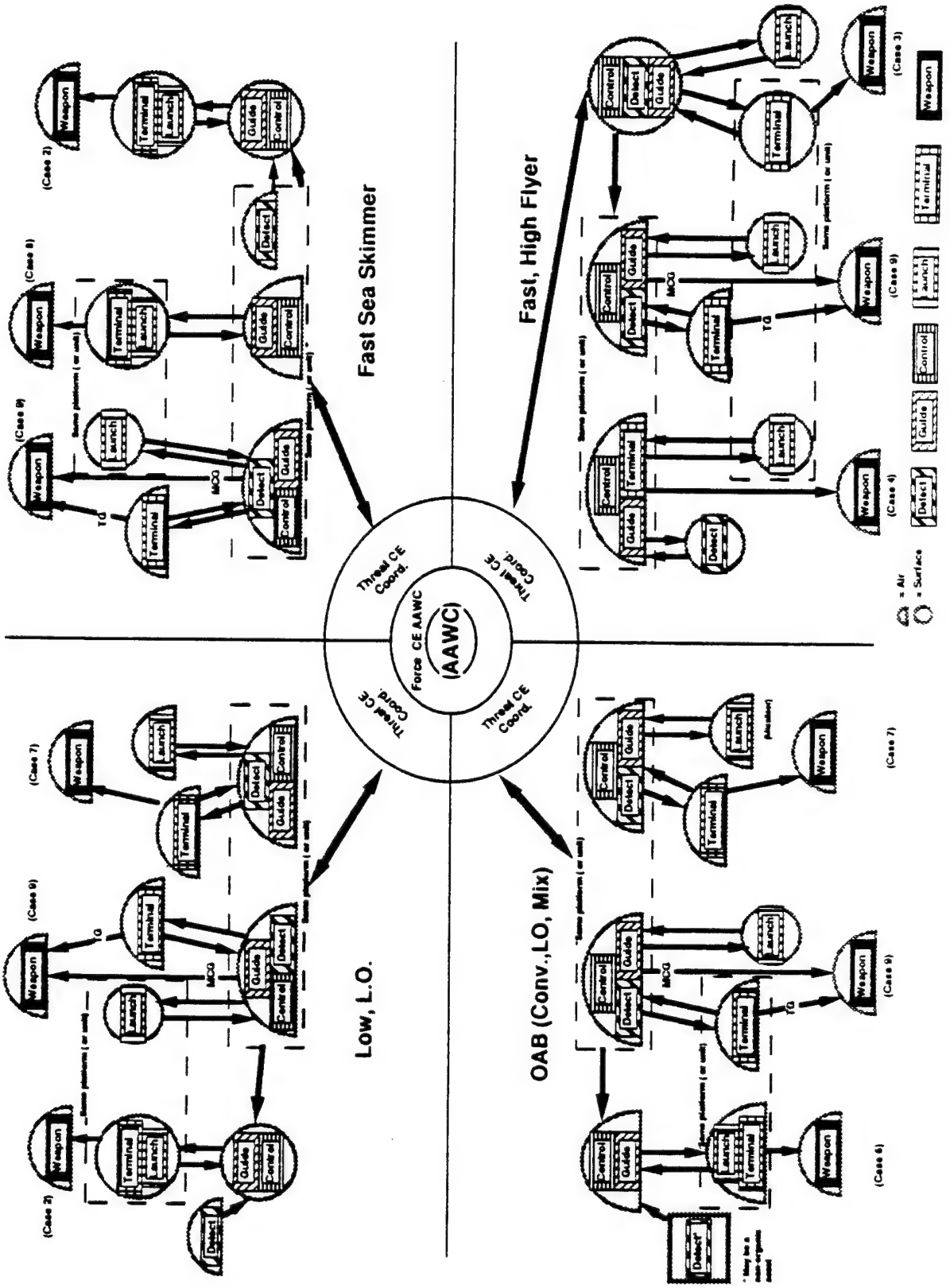


Figure C-33. AAW Threat Based Organization

Moreover, in this organizational structure, the CE Controller would have to use the assets in place where the CE engagement is to take place, or are capable of asset contention with the other threat type coordinators, CE or conventional. In Battle Forces, where CE systems are widely present, CE asset availability may not be a serious limitation.

An AAW Organizational structure based on geography is shown in Figure C-34. It contains Local or Sector AAWCs who then have designated CE Coordinators in each of their respective sectors. Here the asset contention is minimized as all assets assigned to the sector would be available to the CE when the LAAWC assigns a track for CE. A major drawback is that each CE is then structured individually and semi-independently so that the efficient rhythm is lost. Moreover, the nature of targets requiring CE is to proceed through the Battle Space without regard to Local or Sector boundaries. That is not a major problem with conventional engagements (as that is considered prior to track assignment for engagement). But with CE, where multiple assets will be committed over time until the CE is completed, this may cause migration of assets away from locales where initial detection and engagement of CE targets occurs.

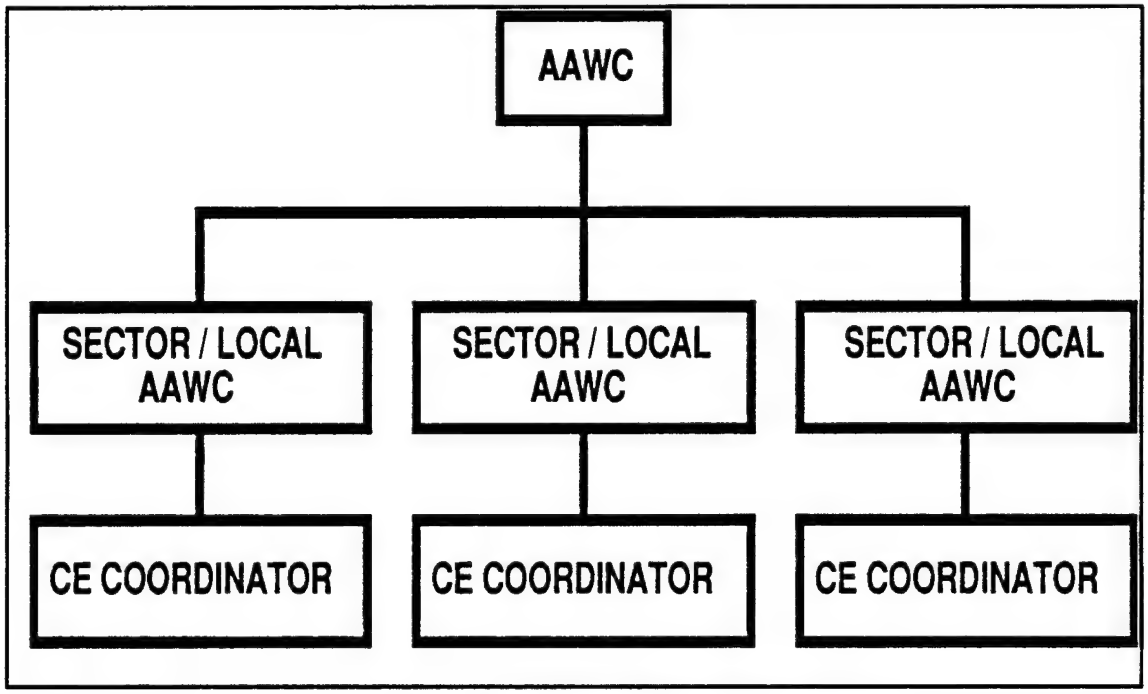


Figure C-34. Geography Based CE Organization

Figure C-35 is a graphic, physical depiction of what it means to organize AAW by geography. There is an Inner and Outer Zone AAWC and under each a CE Coordinator. The heavy dashed line indicates a surveillance and coordination net for the assets assigned to each Zone. The solid heavy lines indicate Zone Coordination nets and a Force Coordination net.

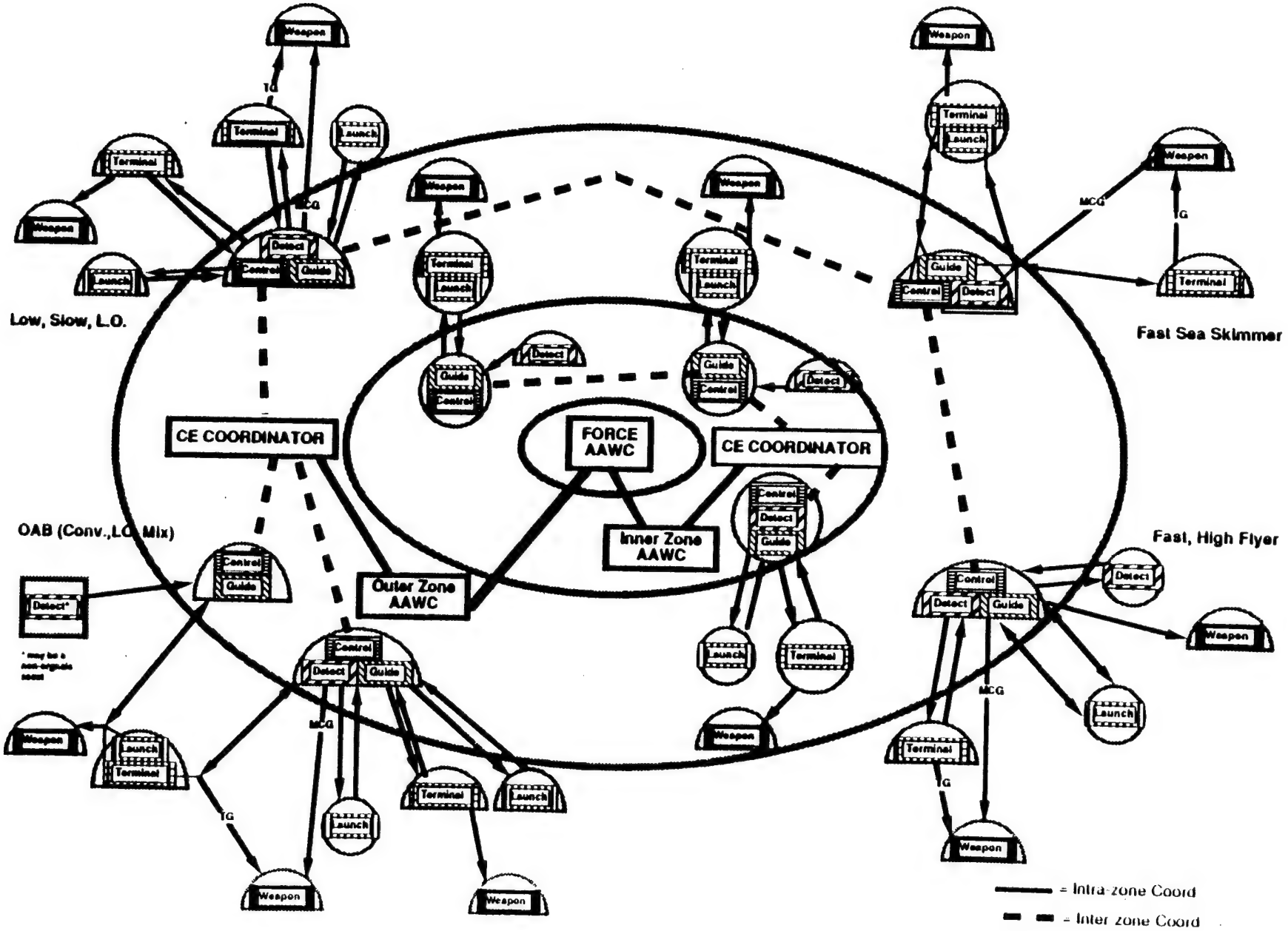


Figure C-35. AAW Geographic Based Organization

The closer tie between a CE Coordinator and his geographic AAWC is apparent as is the tie to the zone assets. However, the migration and discontinuity in engaging threat type is apparent when looking at the set of CE Configurations established for each Threat Type. For example, the transition for dealing with the Fast, High Flyer is abrupt between the OAB (an Outer Zone responsibility) and the use of surface platforms (an Inner Zone responsibility). The fast, high flyer is dumb, it just keeps flying in and crossing the dividing line between inner and outer zones not knowing it is causing a disruption in the smooth engagement transition possible with CE.

3.7 SUMMARY

The architecture effort has developed a functional flow for Cooperative Engagement that evolved from the AAW Architecture. It is adaptable to a variety of threats and warfare areas. The broad structure for the physical and organizational components of the architecture have been developed. These can become more detailed when specific systems and scenarios are selected for evaluation. The architecture can be used in the planning, conducting and evaluation of CE demonstrations.

3.8 AAW CE ARCHITECTURE ISSUES

Table C-1 provides a list of AAW CE issues resulting from development of the CE concept.

Table C-1. CE Architectural Issues

• How will the planning and control of the CE be performed?
• Can the required data fusion be performed?
• Who is responsible for control of the weapon?
• What are the position accuracies required of various platforms and sensors?
• Can assets be scheduled effectively?
• What are the information flow requirements and can they be satisfied?
• How is multi-warfare CE accomplished?
• How is the hard kill/soft kill integration/coordination done

The development of the functional flow for Cooperative Engagement has identified some issues, listed in Table A-1, that must be addressed in the implementation of Cooperative Engagement. Some of these issues are discussed in the following paragraphs.

- How will the planning and control of the CE be performed? Who will do it? Can it be performed by a single individual or must it be distributed? Can it be performed by existing personnel or will it

require additional manpower? How will the data transfer required for control be performed in a timely, reliable fashion?

- Can the required data fusion be performed? How quickly can the fusion be done? How accurately can the fusion be done? What are the interrelationships between the tactical picture and data fusion; between position accuracy and data fusion?

- Who is responsible for the control of the weapon? The launch platform may not have the track on the target but the Commanding Officer of the platform may want to retain control of when and which weapons are launched (e.g., while the LAMPS is being launched may not be the best time).

- Position Accuracy - What are the position accuracy tradeoffs between the tracking assets and the weapon's ability to acquire the proper target?

- Asset Scheduling - How do the assets which detect, mid-course guide, terminal guide and launch the weapon get to the proper position, at the proper time with the proper sensors operating in the proper mode and get the proper information to the appropriate units?

- Information Flow Requirements - What information must be transfered between what units, for what interval of time, with what accuracy to counter a specific threat. (What data on weapons availability and launch platform location must be available to the launch platform to initialize the weapon)

- Expansion/Application to Multi-Warfare - How can the ideas developed here for AAW be expanded to other warfare areas? What organizational changes are needed to accomplish this expansion.

- Hard/Soft Kill Integration/Coordination - How can the utilization of ECM and Hard kill systems be coordinated to enhance the total defense capability.

ANNEX A TO APPENDIX C

OPERATIONAL CASES

The graphics depicted in this annex represent illustrations of the nine Cases shown in the Platform Case Composite in Figure 19 of the Appendix. Each Case is represented as a picture scenario followed by a functional representation. The nine Cases represented are:

- Case 1: Surface Shared Database
- Case 2: Surface Shared Datbase Augmented By Air Surveillance
- Case 3: Surface Shared Database Augmented By Surface Forward Pass
- Case 4: Surface Shared Database Augmented By Air Forward Pass
- Case 5: Air Shared Database
- Case 6: Air Shared Database Augmented With Non-Ogranic Surveillance
- Case 7: Air Shared Database Augmented By Air Forward Pass
- Case 8: Air and Surface Shared Database
- Case 9: Air and Surface Shared Database Augmented By Forward Pass

The first graphics, Figure CA-1, is a reminder of CE top level functions.

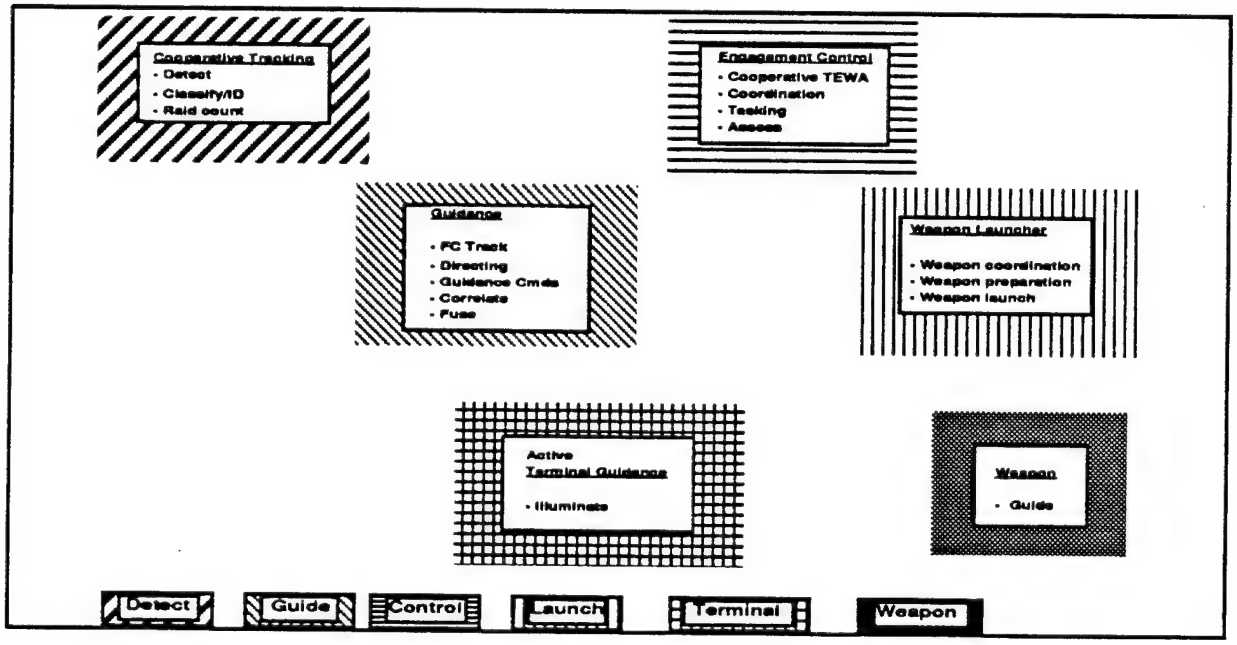


Figure CA-1. AAW Cooperative Engagement Top Level Functions

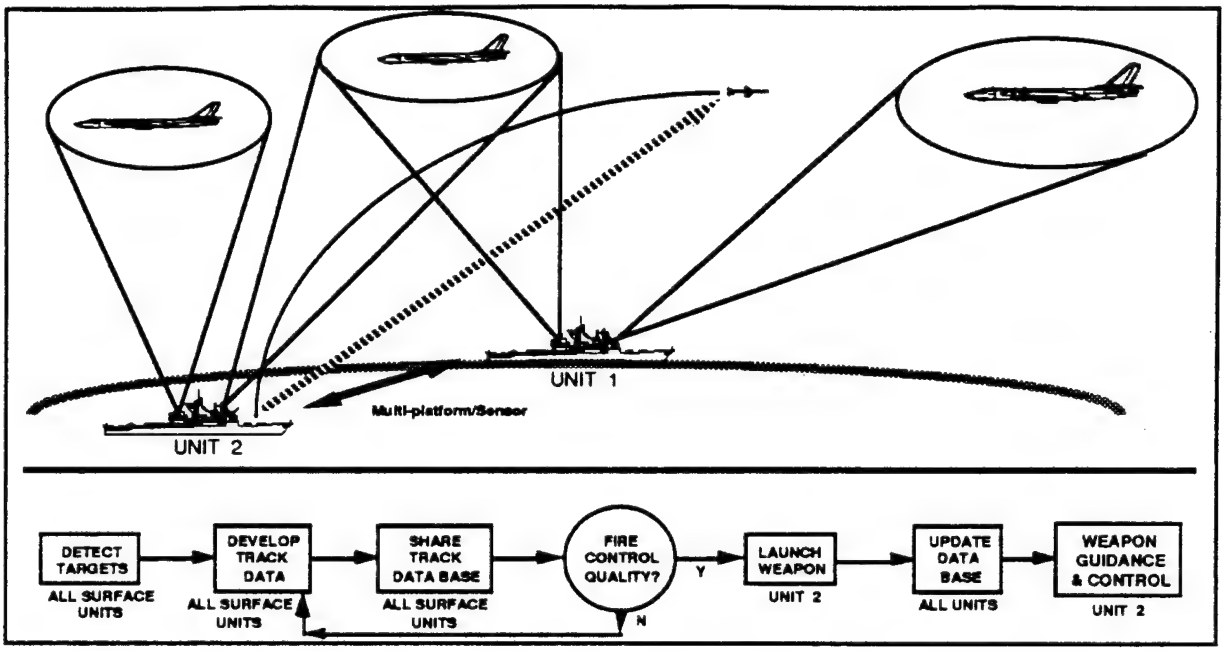


Figure CA-2. Case 1: Surface Shared Database - Graphic Representation

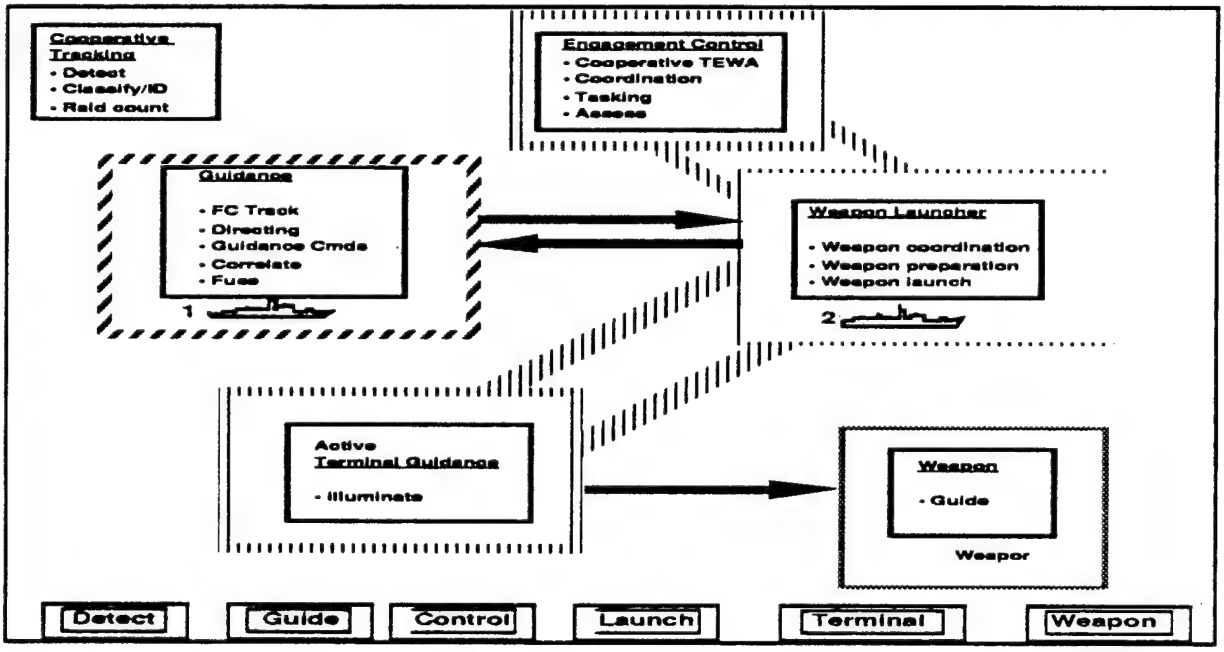


Figure CA-3. Case 1: Surface Shared Database - Functional Representation

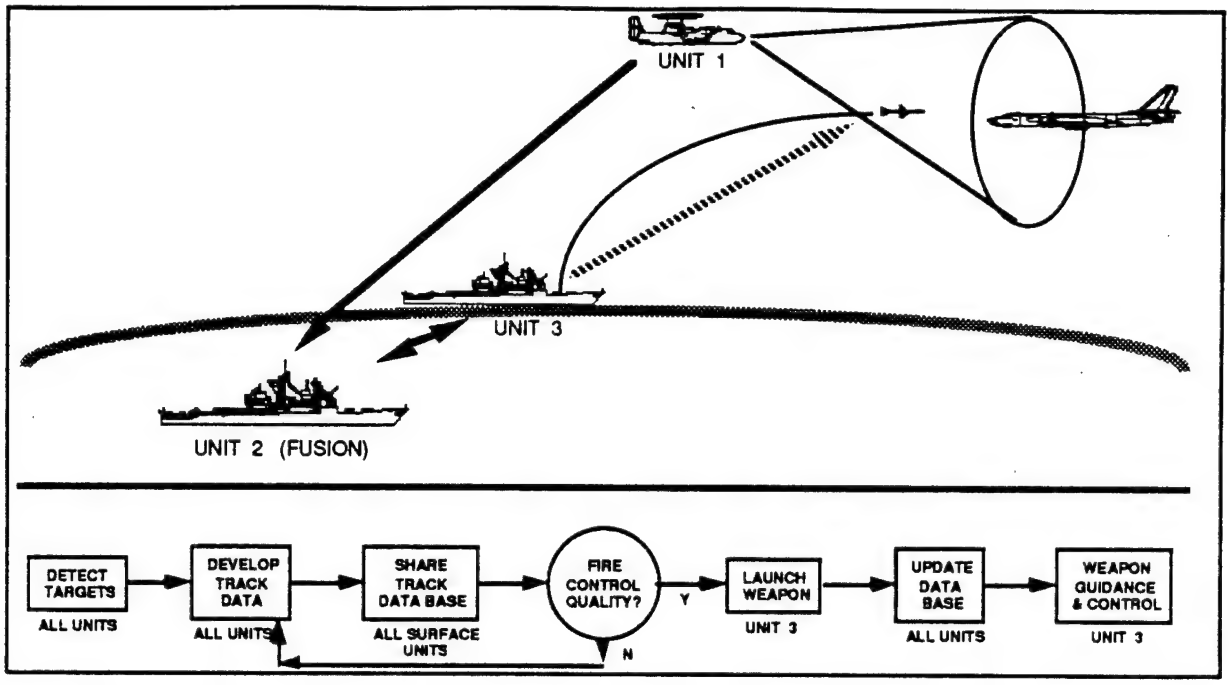


Figure CA-4. Case 2: Surface Shared Database Augmented By Air Surveillance- Graphic Representation

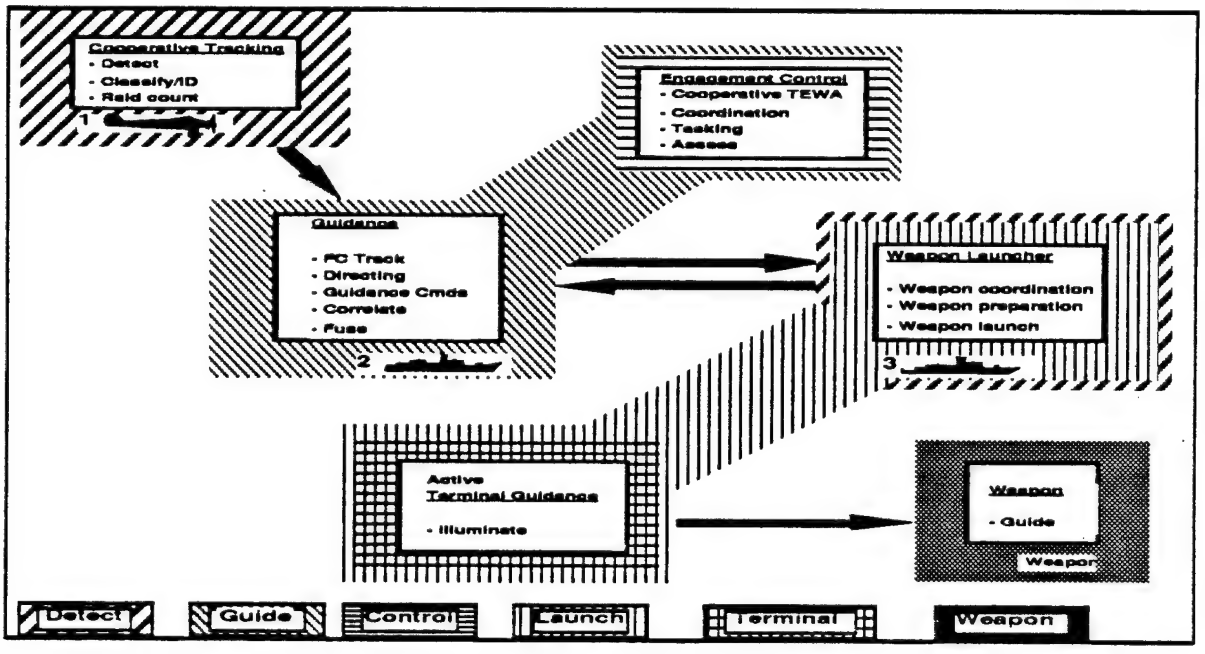


Figure CA-5. Case 2: Surface Shared Database Augmented By Air Surveillance -Functional Representation

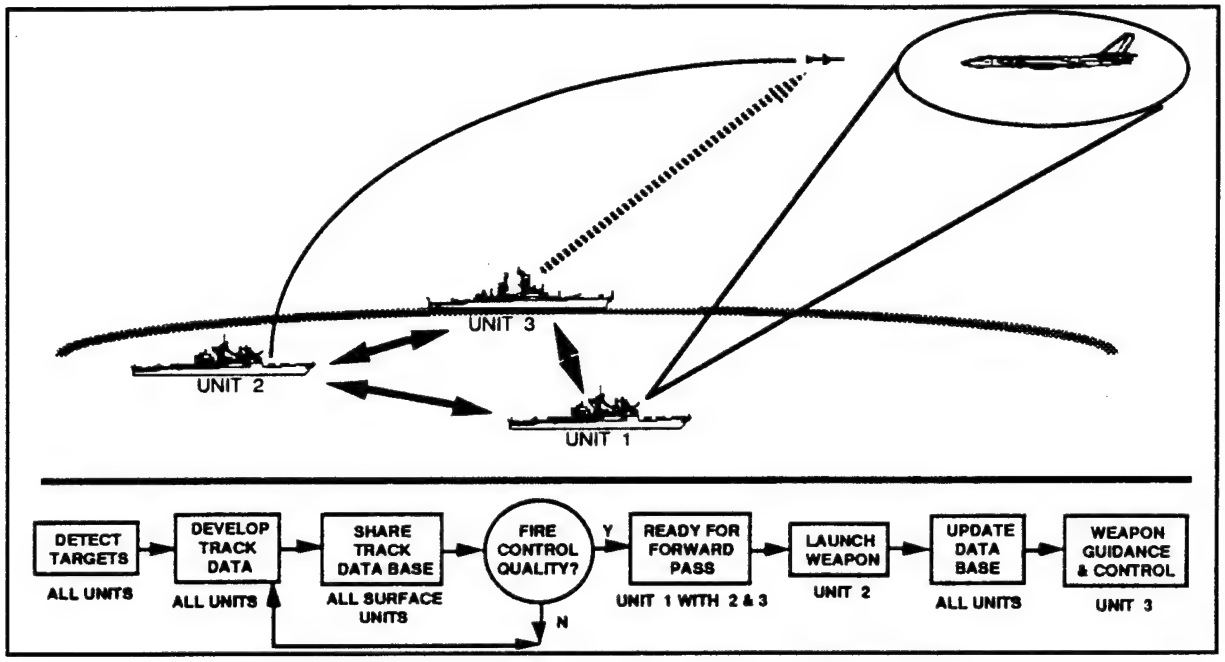


Figure CA-6. Case 3: Surface Shared Database Augmented by Surface Forward Pass- Graphic Representation

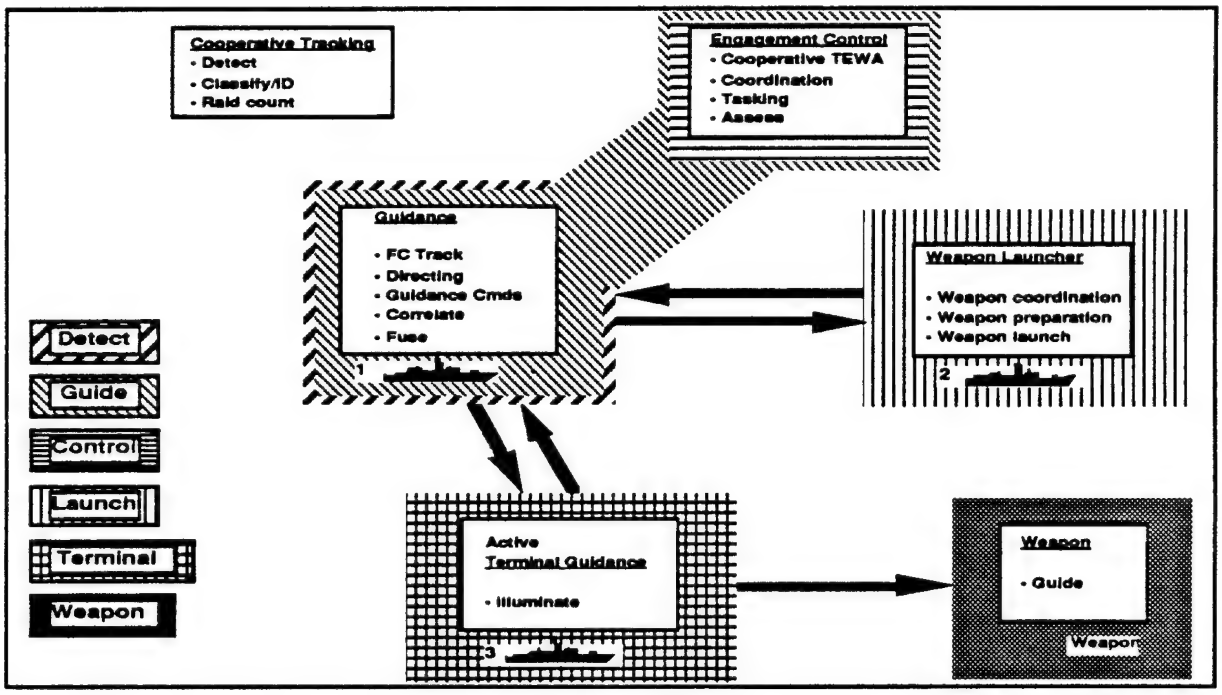


Figure CA-7. Case 3: Surface Shared Database Augmented by Surface Forward Pass - Functional Representation

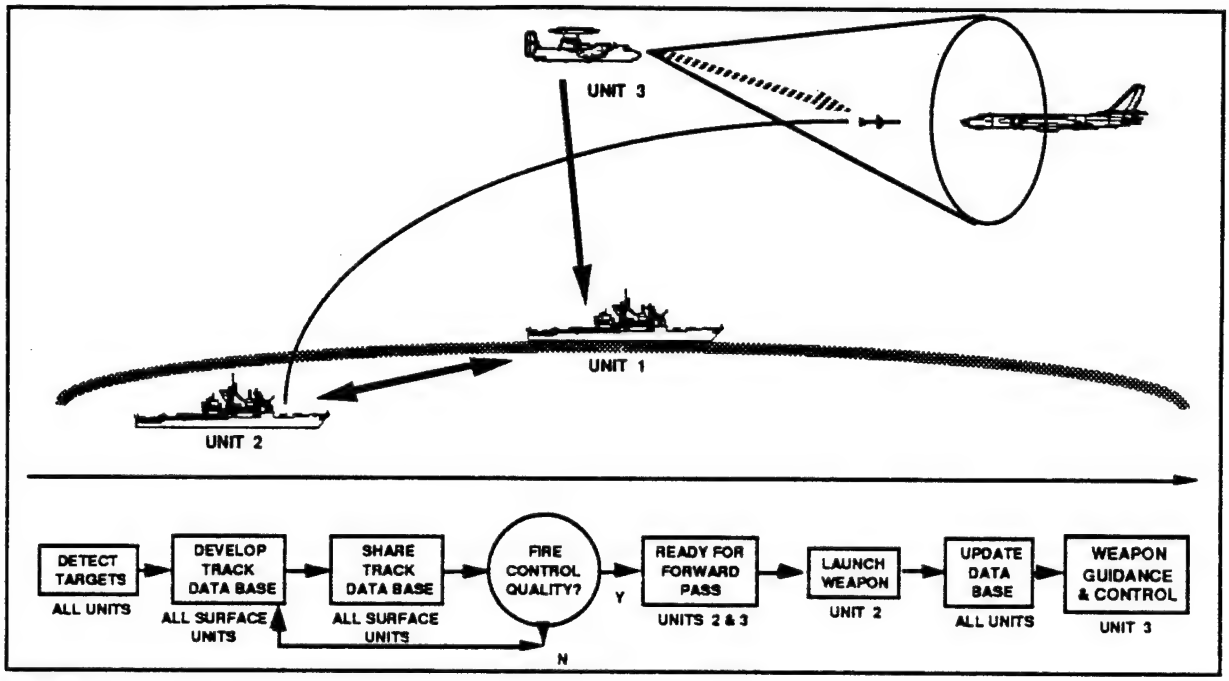


Figure CA-8. Case 4: Surface Shared Database Augmented by Air Forward Pass- Graphic Representation

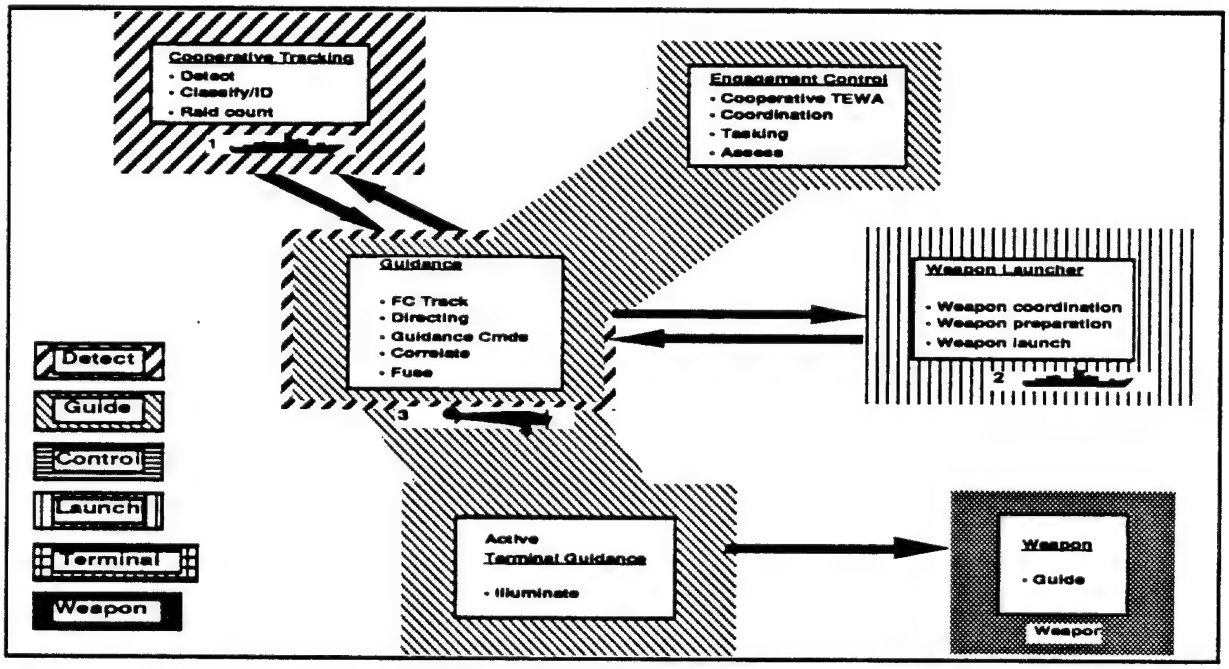


Figure CA-9. Case 4: Surface Shared Database Augmented by Air Forward Pass - Functional Representation

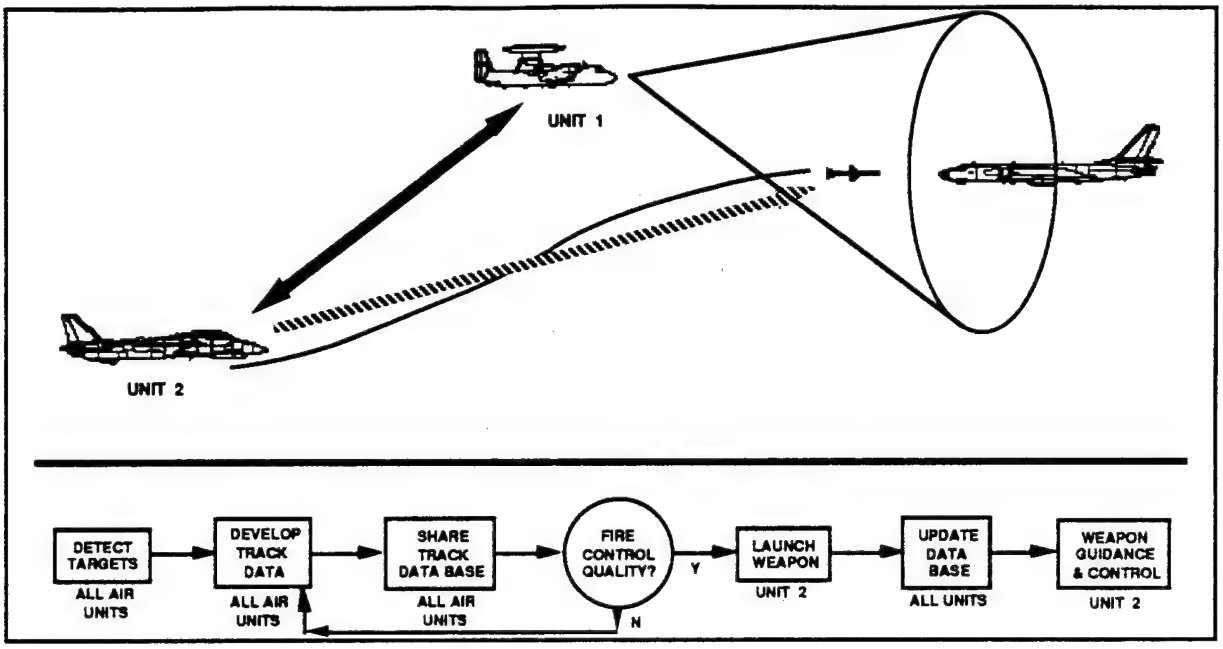


Figure CA-10. Case 5: Air Shared Database - Graphic Representation

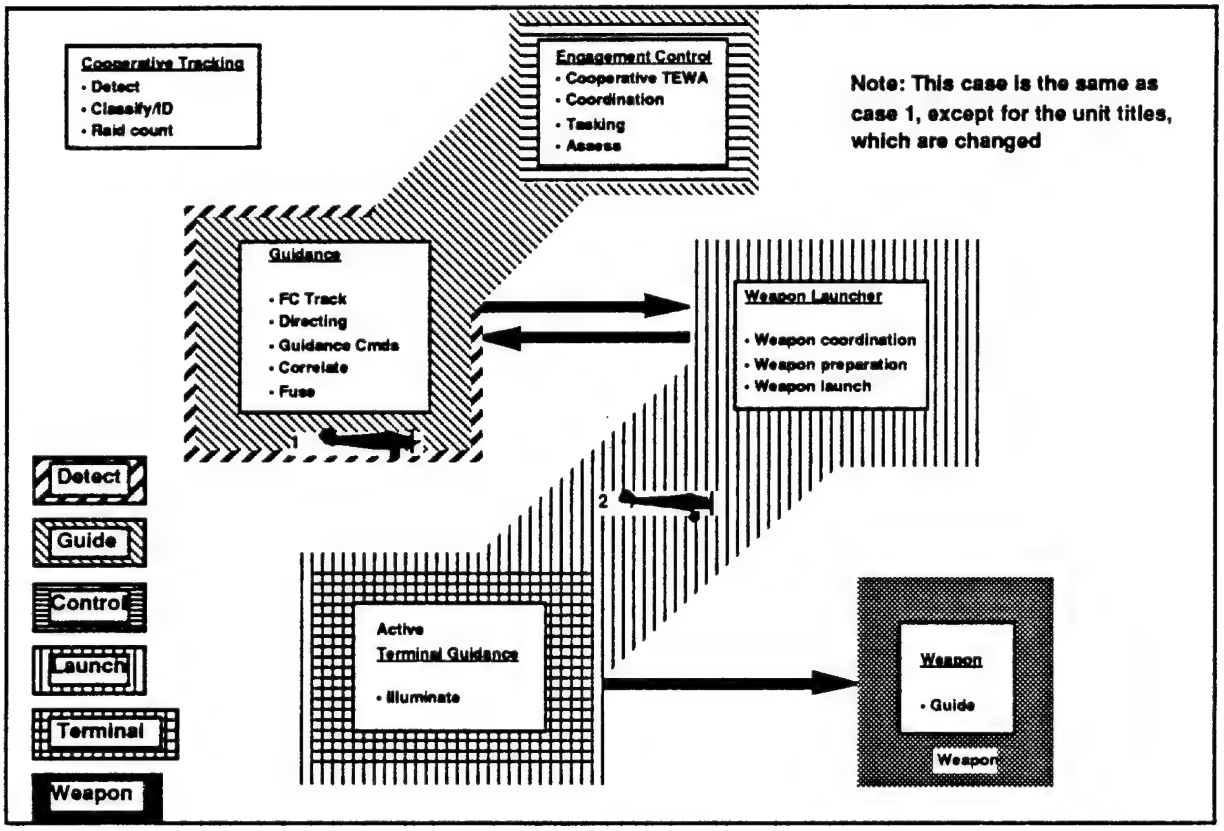


Figure CA-11. Case 5: Air Shared Database - Functional Representation

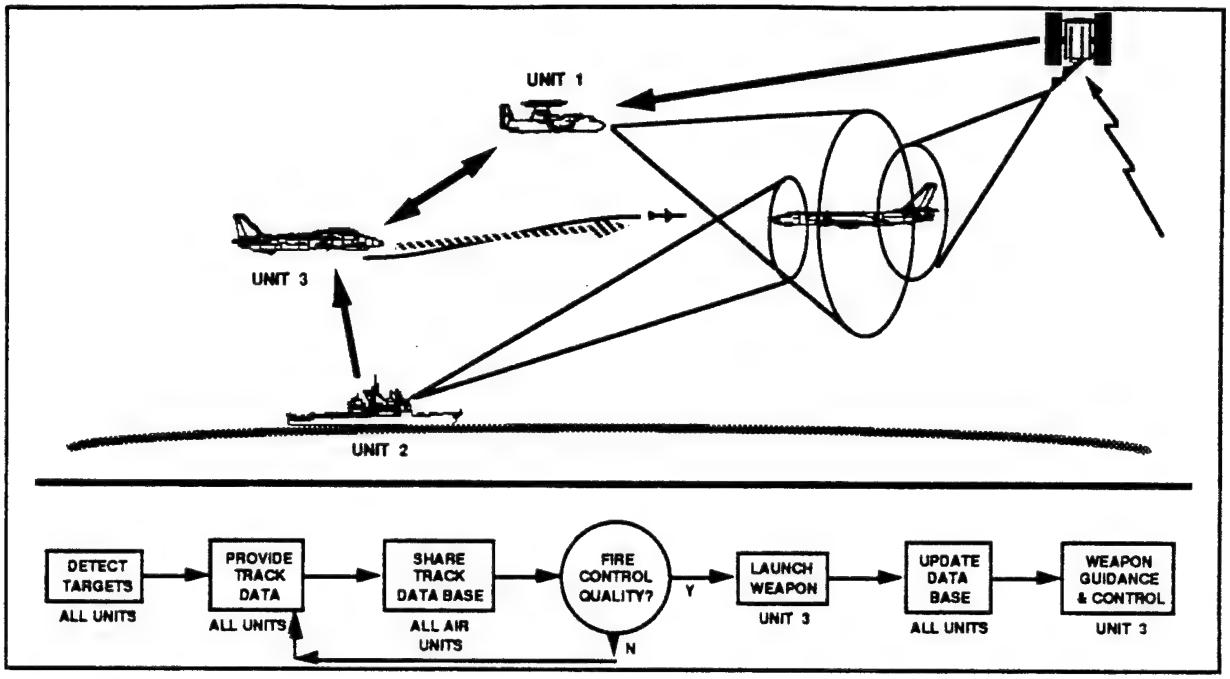


Figure CA-12. Case 6: Air Shared Database Augmented with non-organic Surveillance - Graphic Representation

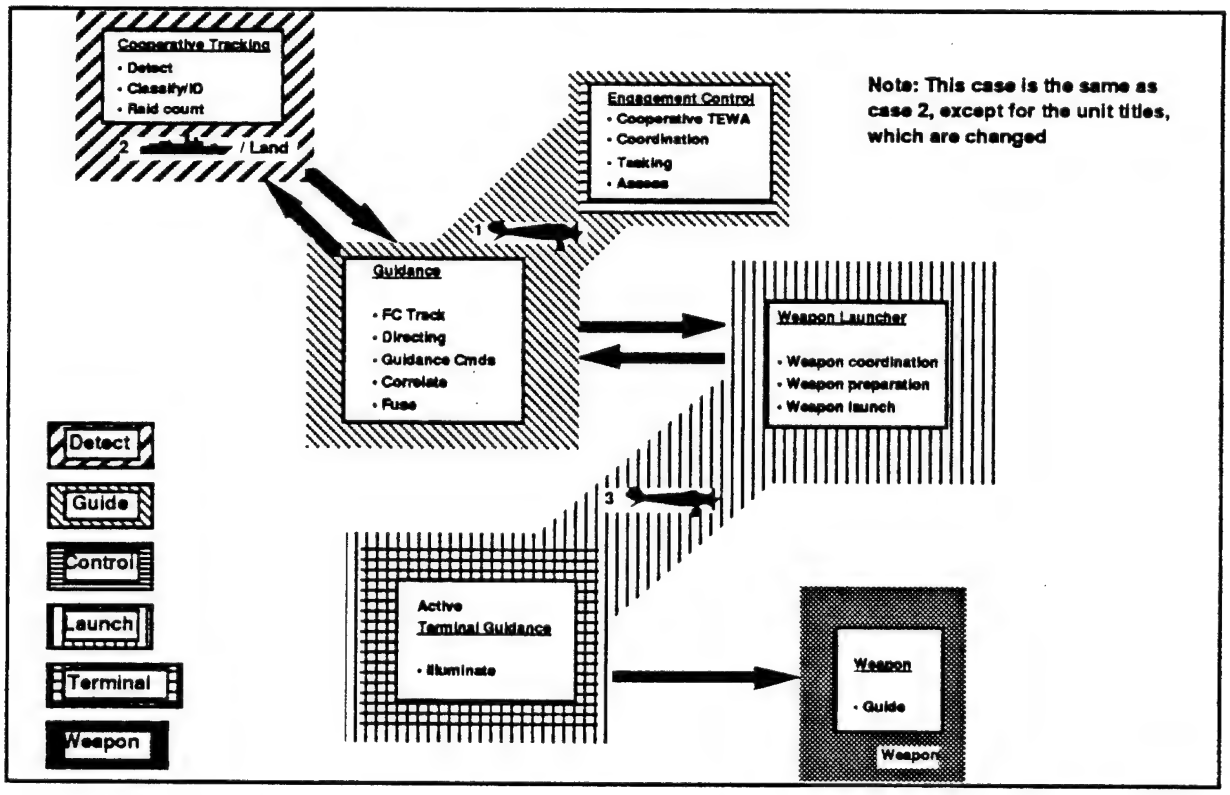


Figure CA-13. Case 6: Air Shared Database Augmented with non-organic Surveillance -Functional Representation

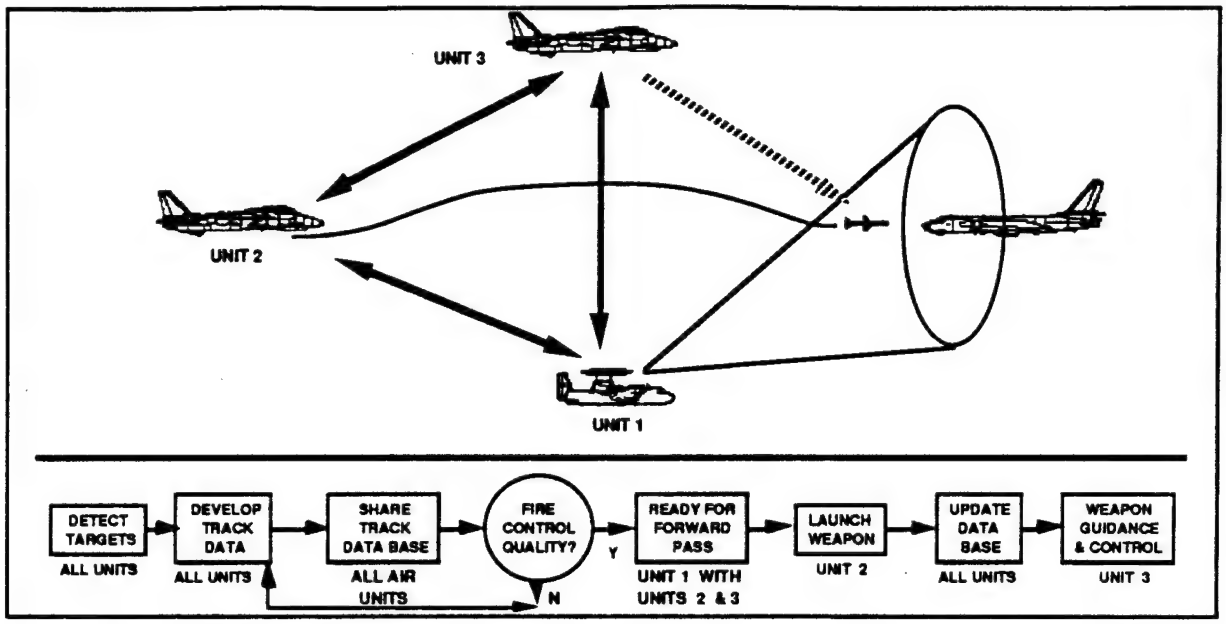


Figure CA-14. Case 7: Air Shared Database Augmented by Air Forward Pass - Graphic Representation

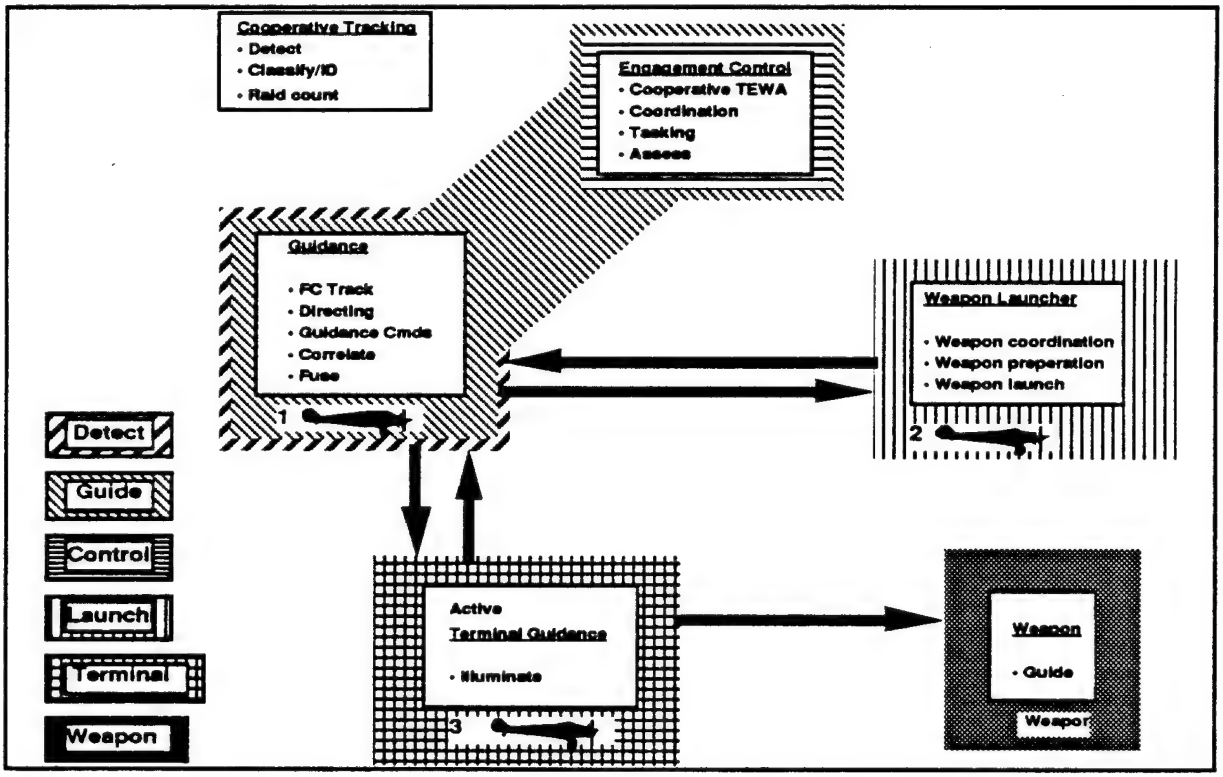


Figure CA-15. Case 7: Air Shared Database Augmented by Air Forward Pass - Functional Representation

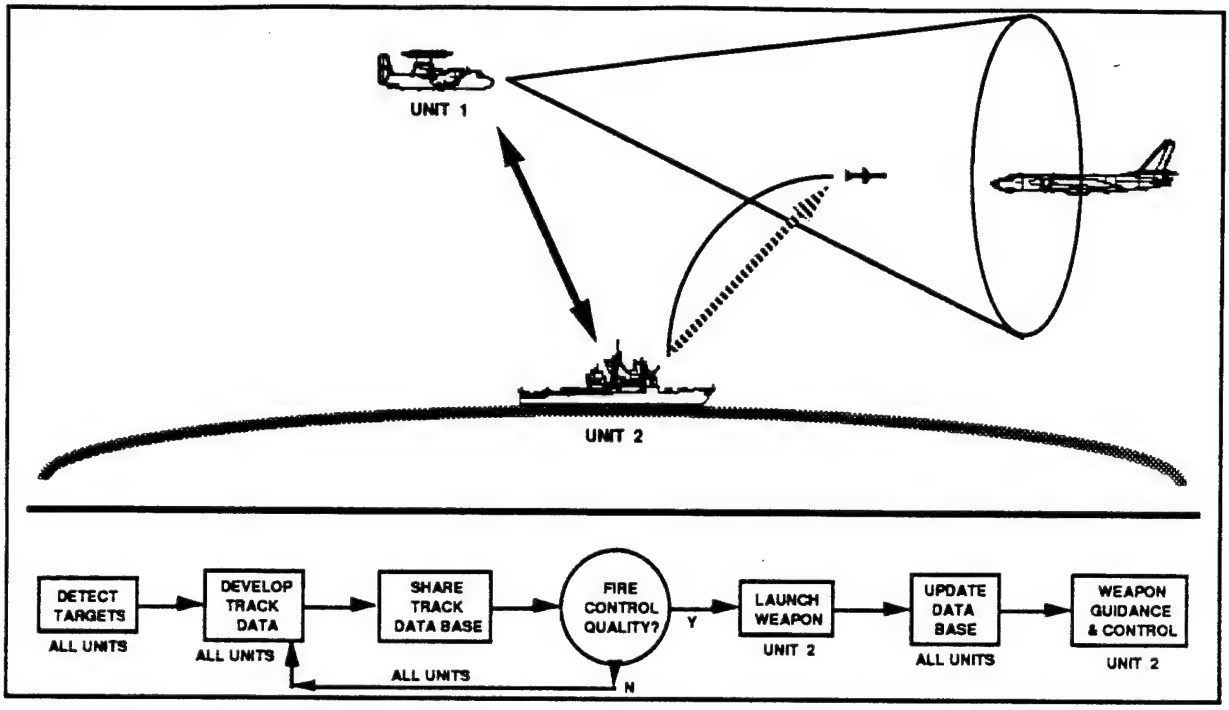


Figure CA-16. Case 8: Air and Surface Shared Database - Graphic Representation

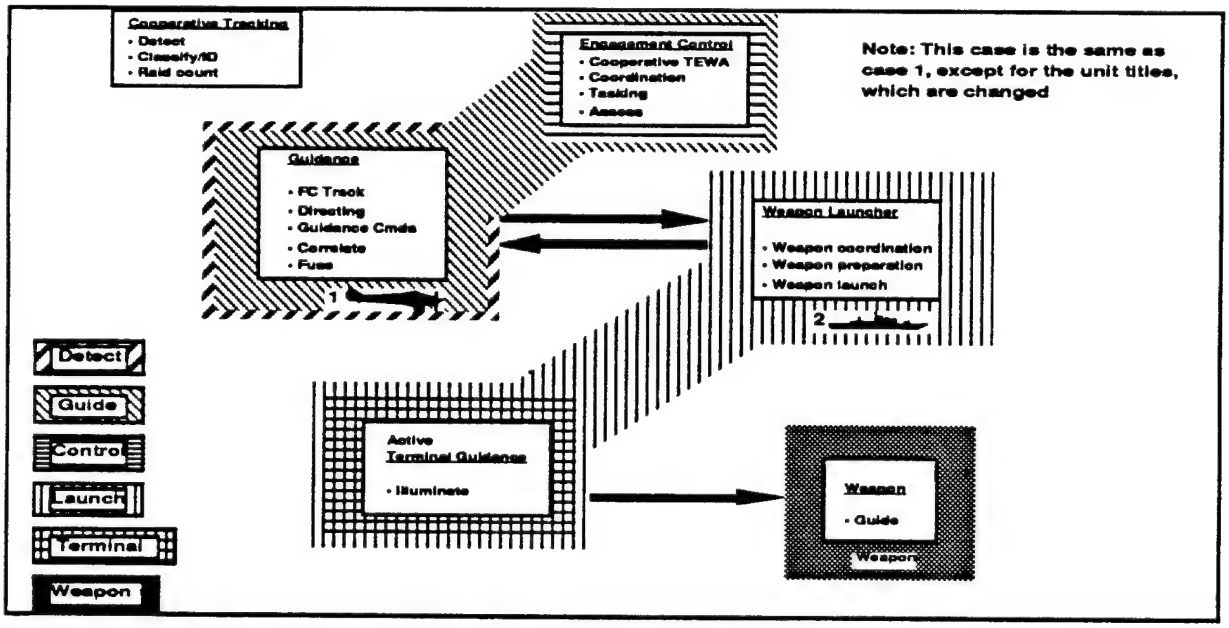


Figure CA-17. Case 8: Air and Surface Shared Database - Functional Representation

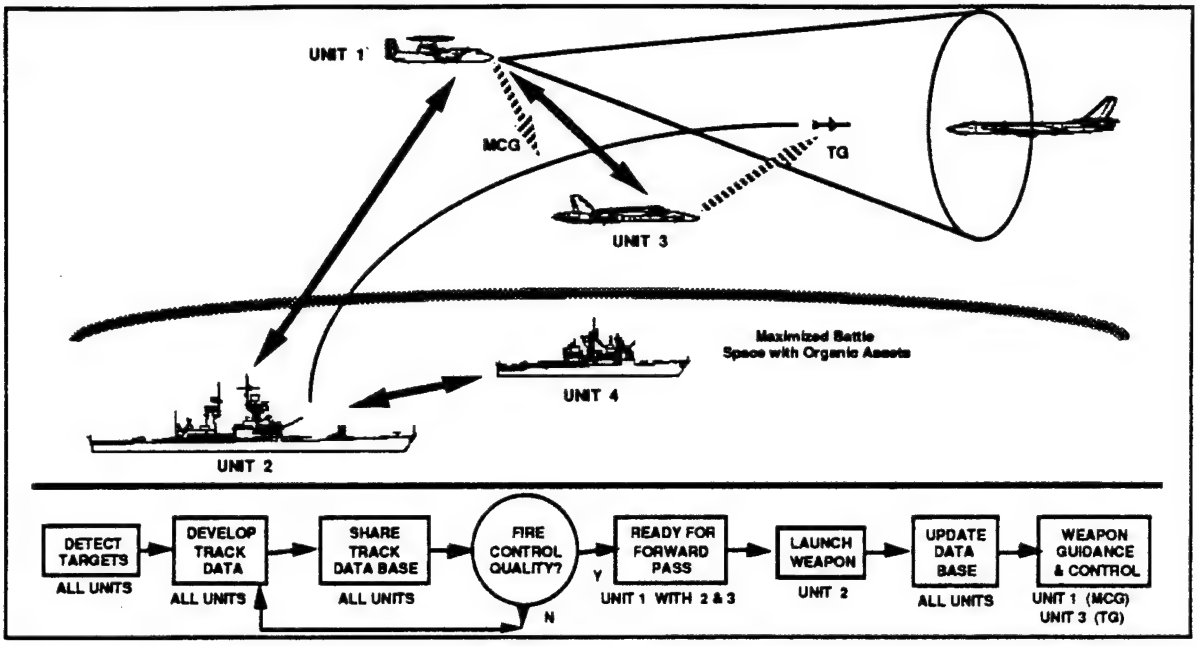


Figure CA-18. Case 9: Air and Surface Shared Database Augmented by Forward Pass - Graphic Representation

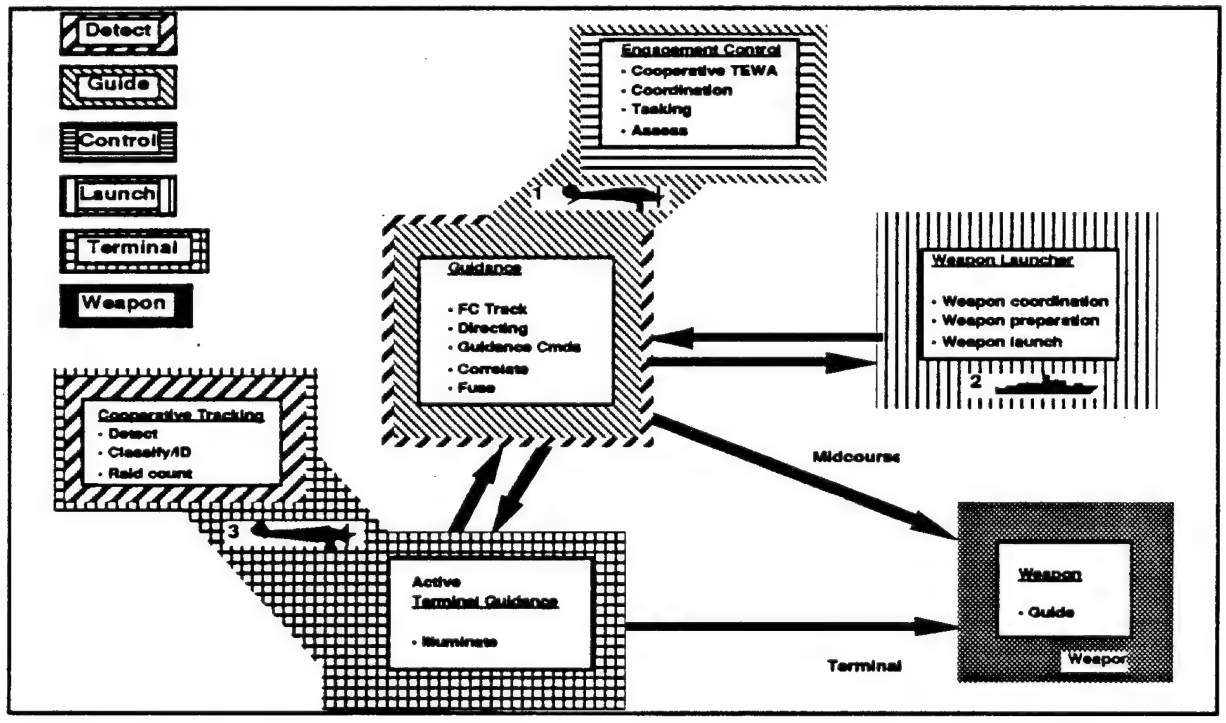


Figure CA-19. Case 9: Air and Surface Shared Database Augmented by Forward Pass - Functional Representation

APPENDIX D

ASSESSMENT METHODOLOGY

By

Landon Elswick
David Taylor Research Center

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 ASSESSMENT METHODOLOGY

1.1 BACKGROUND, ISSUES, AND METHODOLOGY OVERVIEW

Problems in the analysis of defense systems inherently involve tradeoffs between competing system objectives. No system can simultaneously satisfy optimally each of the individual objectives that have been specified for the system. How well specified system objectives are met is measured in terms of the value associated with combinations of system attribute metrics. For example, the objective might be to "reduce system reaction time" and the corresponding attribute would be "time". The metric or measure for the attribute time would be "seconds". The value or "worth" assigned to each numerical value of the metric for the attribute time determines how much each second of reaction time reduction contributes to meeting the overall system object. How best to assess the "worth" of various numerical combinations of different attribute metrics toward meeting competing system objectives is the subject of the assessment methodology section of this report. Also, the determination of the descriptive attributes (not the numerical values) of the Cooperative Engagement architecture is a subject of this section of the report. For assessment purposes, a Cooperative Engagement architecture is a single numerical combination of the metrics of the different Cooperative Engagement attributes. How the combinations of attribute metrics are achieved is the responsibility of system engineering.. The attributes that characterize a Cooperative Engagement architecture are essentially the same attributes that are used to describe the war fighting capabilities of a generic battle force. The architectural assessment question is - what combination of battle force attribute metrics most effectively implements the Cooperative Engagement concept with the subsequent best "net" improvement in battle force performance? In order to answer that question, several candidate analytical techniques were considered - the Analytic Hierarchy Procedure (AHP), Multi-Attribute Utility Analysis, and use of Detailed Simulation Models. The one chosen by the Cooperative Engagement Team's Assessment Group was the Multi-Attribute Utility Analysis (MAUA) technique and that is the technique that is described in this section of the report. The essential steps of the MAUA technique are:

1. Identify the alternatives to be ranked. Alternatives can be any set of objects or courses of action from which a choice must be made. The alternatives in this case are Cooperative Engagement architectures.

2. Clarify the objectives used to rank the alternatives.

   Objectives are the qualitative considerations that influence the desirability of the alternatives. The top level CE objective is improve battle force performance at acceptable cost and risk. The CE assessment effort desires to rank candidate CE architectures and to identify high payoff investment strategies for implementing a Force Level Cooperative Engagement Capability.

3. Identify attributes and their associated measures.

   Evaluation attributes are the variables used to rank the alternatives. The attributes completely describe the alternatives for ranking purposes. An attribute measure is a characteristic of an alternative that is specific enough to be measured.

   Measures must be quantitative and they must be specific enough to allow a number (or probability distribution) to be assigned for each alternative.

4. Quantify the level for each measure for each alternative.

   To rank the alternatives, you must quantify how well each meets your objectives. This is done by defining the level on each of the measures for each of the alternatives. Measures can be defined with point estimates or with probability distributions. Probability distributions are used when the level of a measure for an alternative is not known with certainty and must be described with a probability distribution.

5. Quantify preferences about different levels of the measures.

   There are two steps to accomplish:

   (a) Making Measures Comparable - the common scale used is called the value. The values are scaled to have a range between 0 and 1. To convert the levels for a measure to value you need a value function, or more specifically a single measure value function. The shape of the value curve should depend on the problem and on the decision maker's personal preferences. This is where the subjective and objective elements become distinguished. Identifying the measure levels for an alternative is a more or less objective process, while converting levels to value is inherently subjective.

   (b) Establish the Importance of Each Measure - Once the measures have been made comparable by defining a single measure value function (SVF) for each measure, the next step is to combine the individual SVF values into an overall value for each for each alternative. The equation used to combine the SVF values is called a Multiple-measure Value Function or MVF. A MVF takes a set of levels on the evaluation measures and combines them to arrive at a single number representing the relative desirability of an alternative, called the alternative's overall value. The alternative with the highest overall value is the most preferred.

6. Rank the alternatives by combining information from steps (4) and (5).

7. Perform "sensitivity analysis" to see the effects on the results of changes in measure levels or preferences.

   A sensitivity analysis can be done to identify the effect of changes in the importance of the measures. The sensitivity analysis can also help the decision maker focus on those attributes that should be investigated more closely.
   The remainder of this section of the report will be devoted to elaborating on the concepts alluded to in the 7 steps listed above.

1.2 DETERMINATION OF SYSTEM OBJECTIVES AND ATTRIBUTES

To be useful to the decision maker, an attribute should be both comprehensive and measurable. An attribute is comprehensive if, by knowing the level of an attribute in a particular situation, the decision maker has a clear understanding of the extent that the associated objective is achieved. An attribute is measurable if it is reasonable both (a) to obtain a probability distribution for each candidate Cooperative Engagement alternative over the possible levels of the attribute - or in extreme cases to assign a point value - and (b) to assess the decision maker's preferences for different possible levels of the attribute, for example, in terms of a value function or, in some circumstances, a rank ordering. A comprehensive set of attributes should be relevant to the particular alternative courses of action under consideration and not subject to other extraneous considerations. In the case of Cooperative Engagement, the alternative courses of action are the different implementations of the Cooperative Engagement concept.

1.2.1 Hierarchy of Objectives

In many cases, choosing an attribute will not be difficult if the associated objective is clear. From the assessment viewpoint, the objectives are the means of getting to the associated attributes. The attribute measure levels and the value of those attribute measure levels are the basis for building a system assessment.

Suppose the decision maker has thought hard about the objectives in a given problem and has produced a list that encompasses all the areas of concern. No doubt the different objectives will vary in their scope, explicitness, and detail, and be inconsistent. How can the analyst bring some structure to this list of objectives? Often these objectives can be structured in a meaningful way by the use of a hierarchy. .How is a hierarchy constructed from an original list of objectives? And how do we recognize if, in fact, "holes" are present in the hierarchy? One way is through the decomposition of system objectives. By subdividing an objective into lower level objectives of more detail, the intended meaning of the more general objective is clarified. These lower-level objectives can be thought of as means to an end, the end being the higher level objective. Thus, by identifying the ends to very precise objectives, we can build the

hierarchy up to higher levels. When we go up the hierarchy, there is the natural stopping point at the all-inclusive objective. This objective is broad and indicates the reason for being interested in the problem.

How far should the objectives hierarchy be extended? It depends to a great deal on what will be done next with the hierarchy. Are we going to identify attributes for each of the objectives? This is related to the qualitative versus quantitative growth of the hierarchy and to the concept of direct preference measurements. Are we willing to use subjective indices of effectiveness, or do we prefer objective ones? This question depends partially on who the decision maker is and who is performing the analysis and for what purpose. When dividing an objective into subobjectives, at any level, care must be taken to insure that all facets of the higher level objectives are accounted for in one of the subobjectives. However, we must guard against a proliferation of the hierarchy in the lateral direction as well as the vertical. For instance, if we ended up with hundreds of lower level objectives, which are specifiers of a higher level objective, some might be so insignificant relative to others that they could be excluded from the formal analysis without leading the decision maker astray. Still, care must be exerted in discarding objectives.

In many instances, it might be useful to have a group of knowledgeable experts identify the objectives in a problem area. This process has been formalized in the so-called Delphi technique. The Delphi technique attempts to improve the panel or committee approach in arriving at a forecast or estimate by subjecting the views of individual experts to each other's criticism in ways that avoid face-to-face confrontation and provide anonymity of opinions and of arguments advanced in defense of these opinions. In one version, direct debate is replaced by the interchange of information and opinion through a carefully designed sequence of questionnaires. The participants are asked not only their opinions but their reasons for those opinions, and at each successive interrogation, they are given new and refined information, in the form of opinion feedback, which derived by a computed consensus from the earlier parts of the program. The process continues until further progress toward a consensus appears to be negligible. The conflicting views are then documented.

The objectives hierarchy for a particular problem is not unique. It can be varied by changing the degree to which the hierarchy is decomposed. However, even if the degree of decomposition remains unchanged (in the sense that the number of lowest level objectives remains the same), the objectives hierarchy can be significantly varied. Whether one arrangement is better than another is mainly a matter of the points that the decision maker and analyst wish to make.

1.2.2 Properties of Sets of Attributes

Now ask the the broader question: Is the set of objectives and their associated attributes appropriate for the problem? The set of attributes should be complete, so that it covers all aspects of the problem; operational, so that it can be meaningfully used in the analysis; decomposable, so that aspects of the evaluation process can be simplified by breaking it down into parts; non-

redundant, so that double counting of impacts can be avoided; and minimal, so that the problem dimension can be kept as small as possible.

- COMPLETENESS. A set of attributes is complete if it is adequate in indicating the degree to which the overall objective is met. This condition should be satisfied when the lowest-level objectives in the hierarchy include all areas of concern in the problem at hand and when the individual attributes associated with each of the lowest-level objectives in this hierarchy satisfy the comprehensiveness criterion discussed earlier.

- OPERATIONAL. A set of attributes must be operational. The attribute set must help a decision maker choose a best course of action. The attributes must be meaningful to the decision maker, so that he can understand the implications of the alternatives. They should also facilitate explanations to others.

- DECOMPOSABLE. For an n-attribute problem, an n-attribute value function as well as joint probability distributions for the relevant uncertainties must be developed. It will be difficult to do this if the dimensionality n is even moderately high (e.g. 5) unless the set of attributes is decomposable. By this it is meant that the aforementioned tasks can be broken into down into parts of smaller dimensionality.

- NON-REDUNDANCY. The attributes should be defined to avoid double counting of consequences. One example of such a problem is the evaluation of space vehicles. An input might be "weight" and an output might be "thrust" required to break out of the earth's gravitational field. Weight might only be important because of its implication on thrust.

- MINIMUM SIZE. It is desirable to keep the attribute hierarchy as small as possible. Each time an objective is subdivided, possibilities for excluding important concerns occur. In addition, the difficulties in obtaining joint probability distributions and quantifying multi-attribute preferences increase greatly as the number of attributes increases.

A set of attributes is not unique for a specific problem nor is it unique even for a specific objectives hierarchy. The choice of the attribute set to use depends on the future uses of the analysis, and particularly on assessments of probabilities and values.

What if we have specified an adequate objectives hierarchy and we just cannot find reasonable attributes for some of the lower-level objectives? We cannot go on subdividing objectives forever. In many cases we resolve this problem by using proxy attributes. A proxy attribute is one that reflects the degree to which an associated objective is met but does not directly measure the objective. Thus, proxy attributes indirectly measure the achievement on a stated objective. It could be argued that essentially all attributes are proxy attributes

because nothing can be absolutely measured. There are just varying degrees to which an objective is directly measured.

1.2.3 Cooperative Engagement Attributes Hierarchy

Figure D-1 represents an attributes hierarchy that is associated with the effectiveness of a generic battle force. The hierarchy was developed by representatives from several Navy laboratories. The attributes hierarchy was developed directly from an objectives hierarchy with highly available, highly capability, low cost, low risk, highly survivable, and highly adaptable as the top level objectives for the battle force. The Availability portion of the hierarchy represents the state or condition of the battle force immediately prior to "the battle". At that point the battle force has not been subjected to enemy action. The Adaptability portion of the hierarchy represents the ability of the battle force to change to meet varying circumstances. The Survivability portion of the hierarchy represents the ability of the battle force to continue performing its mission when subjected to enemy action. The Capability portion of the hierarchy represents the ability of the battle force to perform its mission. The Cost "block' represents the total life cycle cost of the battle force. The Risk "block" represents the probability of achieving varying combinations of Availability, Capability, Survivability, Adaptability, and Cost. The value function for each of the attributes will change as the mission of the battle force changes. The mission will change because the vital interests of the United States will change and the threat to those vital interests will change. With the attribute set established, the "weight" or emphasis that each attribute carries will be changed as the missions specified for the force are changed.

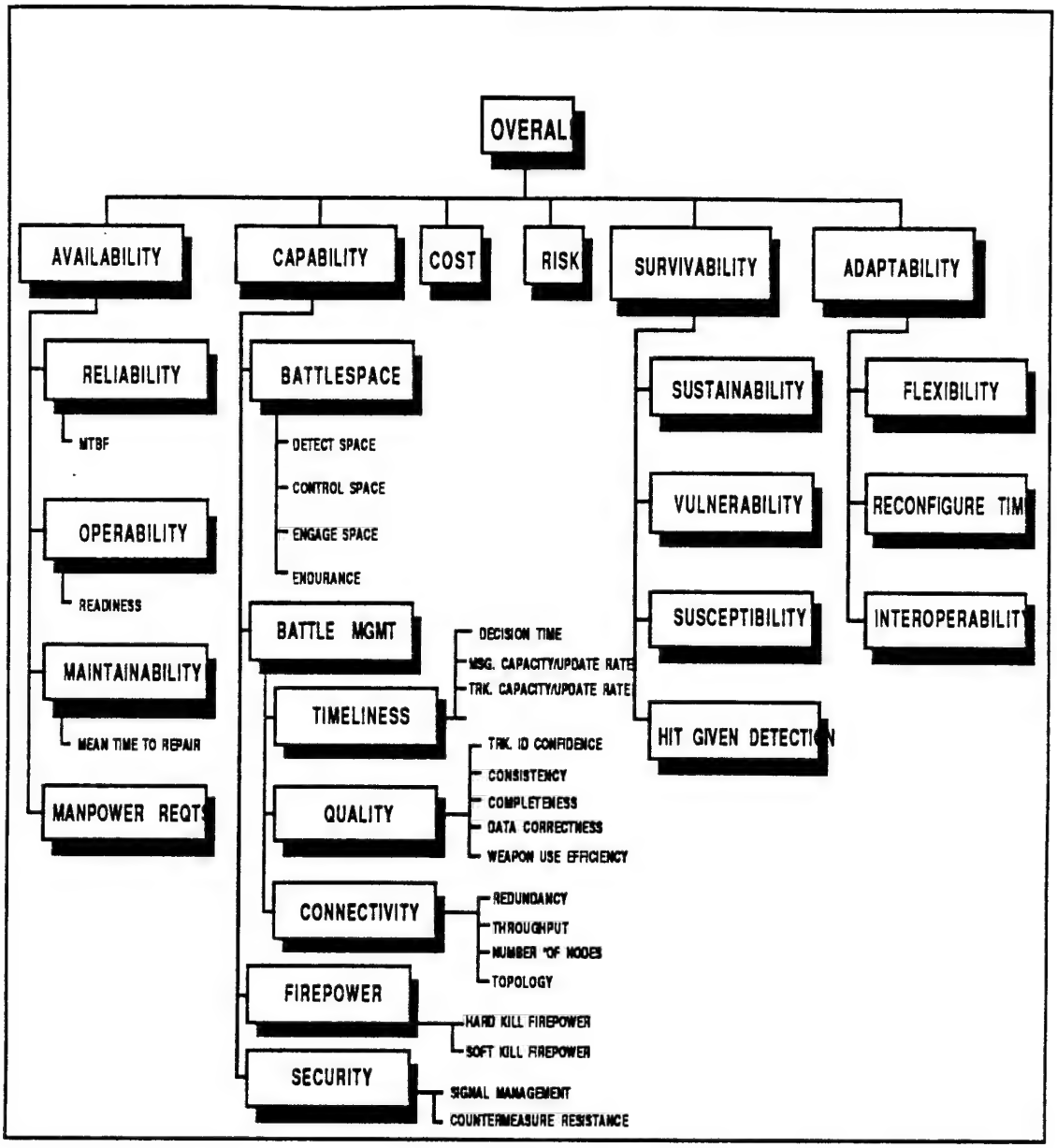


Figure D-1. Attributes Hierarchy

As can be seen from Figure D-1, the "higher level" attributes have been decomposed to the level necessary to adequately represent a generic battle force. Concrete measures are developed only for the "lowest" level members of each branch of the attribute hierarchy. These lowest level measures are combined through the use of value functions (to be discussed in a later subsection). The general scheme is to combine the value at each level of the attribute hierarchy to eventually arrive at a value for the "top level" or "OVERALL" attribute. The methods for developing value functions and combining them will be discussed in a later subsection of the ASSESSMENT METHODOLOGY section of this report "OVERALL" at the top of the of the attribute hierarchy represents the relative "worth" of the battle force toward achieving the given mission with given "values" of the generic attributes. The

"values" of the attributes are derived from specific architectural implementations designed to achieve the specified mission. The "OVERALL" attribute is a measure of the overall objective of identifying high payoff investment strategies for implementing Cooperative Engagement Capability designed to improve the battle force effectiveness in response to specified mission requirements.

1.3 DEFINITIONS OF THE ATTRIBUTES

- Availability: the probability that the battle force capabilities will be available given system reliability, operability, maintainability, and manpower requirements.

- Reliability: the probability that a system will perform its intended function for a specified length of time under stated conditions.

- Mean Time Between Failure (MTBF): the primary measure of system reliability and is computed by dividing the total mission time by the number of failures (mission ending failures) that are expected to occur during that time.
  - Measure: compute as explained above - hours/failure

- Operability: the measure of the ease with which the system can be used.

- Readiness: the probability that military forces, units, weapon systems, equipments and personnel will be capable of undertaking the mission and function for which they are designed or organized, at any random point in time.
  - Measure: 0 to 1 probability

- Maintainability: the measure of the ability of an item to be retained in or restored to a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance.

- Mean Time to Repair: the average amount of time to restore the system mission capability after a failure not due to damage inflicted by the enemy.
  - Measure: hours

- Manpower Requirements: the total number and skill level distribution of the people required to fight the battle force.
  - Measure: total number in each skill level multiplied by a skill level index that indicates amount of training involved.

- Capability: measure of the capacity to which the battle force can perform its mission.

- Battle Space: the volume and time associated with the detection, control and engagement space for the battle force.Detect Space: the volume and time associated with the target detection and classification capabilities of the battle force.Measure: nautical miles

- Control Space: the volume and time associated with the target track and asset control capabilities of the battle force.
  - Measure: nautical miles

- Engagement Space: the volume and time associated with the target engagement capabilities of the battle force.
  - Measure: nautical miles

- Endurance: the length of time over which the force must be capable of maintaining its battle space.
  - Measure: hours

- Battle Management: the capacity of the battle force to effectively utilize all available assets to accomplish the mission.

- Timeliness: the characteristic of the data that is concerned with the question - does the proper data arrive at the proper place in time to improve the quality of the decisions that are made in fighting the battle force?

- Decision Time: the amount of time it takes to decide how to employ the battle force assets to counter a specific threat. This is not the "reaction time". Reaction time is defined to be the time from initial target detection to first defensive missile movement on the launcher rail. Reaction time is associated with single platform engagement where the decision time attribute is related to employment of whole battle force assets.
  - Measure: seconds

- Message Capacity/ Update Rate: the number of messages that can be processed per unit of time by the battle force. The rate at which information necessary to efficiently fight the battle force can be disseminated to and understood by the individual unit commanders.
  - Measure: number/hour

- Track Capacity/ Update Rate: the number of target tracks that can be processed per unit of time by the battle force. The rate at which new tracks can be added and "old" tracks can be updated to aid commanders in making decisions concerning allocation of battle force resources.
  - Measure: number/hour

- Quality: the characteristic of the data that is concerned with the question - is the data of high enough quality to improve the decisions that are made in fighting the battle force?

- Track Identification Confidence: the probability that a target track has been properly identified.
  - Measure: 0 to 1 probability

- Consistency: the probability that the data quality and timeliness will remain constant under the conditions likely to be encountered by the battle force.
  - Measure: 0 to 1 probability

- Completeness: the percentage of the data that is needed to fight the battle force that is actually present at the proper place at the proper time.
  - Measure: percentile number

- Data Correctness: the percentage of the data received by the individual battle force element commanders that is in agreement with the data that was transmitted to them.
  - Measure: percentile number

- Weapon Use Efficiency: the capacity of the battle force to avoid redundant engagements.
  - Measure: percentage of unintentional redundant engagements of total engagements

- Connectivity: degree to which battle force resources are able to share information and distribute required functions.

- Redundancy: the excess in capability required to share information and distribute functions.
  - Measure: percentage excess capacity

- Throughput: the time that it takes for information required to fight the battle force to be distributed throughout the battle force. The time that it takes information to reach the receiver and for the transmitter to receive acknowledgment that the information was correctly received and for the transmitter to get ready to send more information. In other words, it is the total cycle time.
  - Measure: seconds

- Number of Nodes: the total number of signal processing points (locations) within the battle force.
- Measure: integer number

- Topology: the basic geometrical configuration of the resources within the battle force.

- Measure: integer number associated with a type or class

- Firepower: the total engagement capacity of the battle force.

- Hard Kill Firepower: the number of threats that can be successfully prosecuted by all hard kill assets of the battle force: missiles, guns, high energy weapons, etc.
  - Measure: maximum number of threats that could be "killed" by all hard kill weapons if Pk=1

- Soft Kill Firepower: the number of threats that can be successfully prosecuted by all soft kill assets and activities.
  - Measure: maximum number of threats that could be defeated by soft kill weapons if Pk=1

- Security: the integrity of data communication, proficiency of signal management & countermeasure resistance.

- Signal Management: the ability to control battle force electronic emissions to reduce the probability of intercept by the enemy and increase the probability of reception by friendly forces.
  - Measure: ratio of friendly receptions to enemy intercepts

- Countermeasure Resistance: electronic counter-countermeasures, preventing the enemy spoiling own ship's transmissions.
  - Measure: 0 to 1 probability that an enemy countermeasure will be countered

- Cost: the total life cycle cost associated with a specified combination of values or levels of the other attributes in the attribute hierarchy.
  - Measure: current year dollars

- Risk: the probability that a specified combination of attribute levels can be achieved for a specified life cycle cost within a specified amount of time.
  - Measure: 0 to 1 probability

- Survivability: resistance of the battle force to sustaining damage from enemy attack, along with its ability to perform in a partially damaged state, and its ability to restore some of its destroyed capability .

- Sustainability: the probability of military forces, units, weapon systems, equipments and personnel maintaining a specified level of operational capability for a specified length of time.
  - Measure: 0 to 1 probability

- Vulnerability: the probability that the system will lose mission capability when "hit" by enemy offensive capabilities. The term "hit" could refer to an electromagnetic pulse generated from a nuclear air

burst all the way to a kinetic energy round fired from a surface ship gun.
  - Measure: 0 to 1 probability

- Susceptibility: the probability that system can be detected, classified, identified, and targeted with enemy offensive capabilities.
  - Measure: 0 to 1 probability

- Hit Given Detection: the probability that the system can be "hit" by enemy offensive capabilities given that it has been detected, classified, identified, and targeted. "Hit" in the same sense that it is used in the vulnerability definition.
  - Measure: 0 to 1 probability

- Adaptability: measure of the ability of the battle force to respond to changing environmental conditions, e.g.., the ability to extend boundaries, reconfigure, and interoperate with external assets.

- Flexibility: capacity of the battle force to respond to changing war fighting environments (multi-mission capability). The number of warfare mission areas in which the battle force is capable of operating (AAW, ASW, ...) plus the number of different types of operations that the battle force is capable of handling (strike, amphibious assault, CALOW).
  - Measure: rated on a relative scale from 0 to 10

- Reconfigure Time: ability of the battle force to reconfigure to accommodate mission change, damage, or threat countermeasures.
  - Measure: hours for each category of change mentioned above with final input being the average over all of the categories.

- Interoperability: the ability of systems, units or forces to provide and accept services from other systems, units or forces, and to use the services so exchanged to enable them to operate together.
  - Measure: rated on a scale from 0 to 10.

1.4 DETERMINATION OF VALUE FUNCTIONS

A function v, which associates a real number v(x) to each point x in an evaluation space, is said to be the value function representing the decision maker's preference structure provided that:

x' I x" implies v(x')=v(x") and v(x')=v(x") implies x' I x"
where I means "indifferent to"
x could be a vector (x1, x2, x3, ... , xn) or a scalar quantity

The x's are the measures for the attributes that describe the system that is being assessed. The equations above simply state that if the decision maker does not

care whether he has the x' or x" level of x then the value function should reflect that lack of preference (indifference) and should be equal at x' and x", v(x')=v(x").

The term decision maker is generic and could be a committee of experts and the value functions could be constructed using the Delphi technique that was briefly discussed in the section entitled Hierarchy of Objectives.

Example: If an infantry rifleman (decision maker) knows that even in the most severe fire fight that he can't expend more than 5 magazines of ammunition and that he will always be able to get more rounds before the next fire fight then he would be indifferent to the choice between 5 magazines and 6 magazines. In fact, since he has to carry the ammunition, he would prefer 5 magazines of ammunition to 6 magazines. His value function should reflect that preference. Whereas he would definitely prefer 2 magazines of ammunition to 1 magazine if the "normal" fire fight requires that he expend 2 magazines of ammunition.

> x' P x" implies v(x')>v(x") and v(x')>v(x") implies x' P x", where P means "preferred to", v(2)>v(1) reflects the fact that the rifleman prefers 2 magazines of ammunition to 1 magazine

In the example, the measure was a scalar quantity. The same concept holds for the case where x is an ordered set of scalars or vector quantity.

It must be kept in mind that for the methodology described in this section of the report, that value functions are being described, not utility functions. The Multi-Attribute Utility Analysis concept applies to both types of functions. The methodology described in this report is a Multi-Attribute Value Analysis.

Value functions are deterministic indicators of the worth of an alternative when specific numerical quantities are assigned to the attribute measures (x1, ... , xn). In other words, for value functions, with each alternative is associated a fixed numerical combination (x1, ... , xn). Utility functions are used when uncertainty is involved. When using utility functions, each of the components of x will take on a specific numerical quantity with a given probability as a result of selecting a specific alternative. When using value functions, each of the components of x will take on a specific numerical quantity with certainty as a result of selecting a specific alternative.

The crux of the assessment methodology described in this report is to use a multi-measure value function to determine the relative worth of competing CE architectures. This MVF is derived from the single measure value functions (SVF) that represent the decision maker's preferences for the lowest level attribute measures. The term "lowest level" refers to the placement of the attribute in the attribute hierarchy.

1.4.1 Determination of the Single Measure Value Functions. Single measure value functions relate the decision maker's preferences to varying levels of the lowest measures in the attribute hierarchy. How is the SVF

constructed? There are qualitative and quantitative characteristics of the SVF. The qualitative characteristics of a SVF should be thought about first by the decision maker. Answering a series of questions should help guide the decision maker in determining the qualitative characteristics of the SVF.

(a) Does the value increase or decrease as the measure increases?
(b) Does the value increase (or decrease) monotonically with the measure? That is, does the value always increase (decrease) with increases in the measure or is there a level of the measure above which further increases causes a decrease (increase) in the worth of that attribute?
(c) Assuming that the value function is monotonically increasing (the same type of question would apply for a monotonically decreasing functions) - does the change in the magnitude of the value function per unit increase in the measure:

(1) stay the same,
(2) decrease, or
(3) increase as the magnitude of the measure increases?

Option (1) means that the value is a linear function of the measure. Option (2) means that the value is a concave function of the measure (the slope of the curve decreases as the measure magnitude increases). Option (3) means that the value is a convex function of the measure (the slope of the curve increases as the measure magnitude increases). Some value functions are convex over the lower range of the measure and concave over the upper range of the measure (the so-called "S-shaped" value function).

After the qualitative characteristics have been identified, we need to assess quantitative magnitudes for a few particular points on the value function. The analyst could then fair in a "smooth" value function satisfying the qualitative characteristics and the quantitative assessments, or perhaps assess appropriate parameter values for an appropriate family of value functions that exhibit the qualitative specifications that have been discussed above. Now, consider the quantitative assessments.

The quantitative characteristics of the SVF are also assessed by having the decision maker consider a series of questions:

(a) What are the bounds for the attribute measure that is being considered? Stated differently, what is the least magnitude of the attribute measure to consider? The least magnitude will be a numerical quantity that has a value of zero - also any magnitude below that will have zero value and any magnitude above that magnitude will have a positive value. What is the maximum magnitude of the attribute measure to consider? The maximum magnitude will have a value of one and any magnitude greater than

that magnitude will have a value of one. Magnitudes of the attribute measure that are less than the maximum magnitude will have a value of less than one. This explanation holds for a monotonically increasing value function - the opposite relationships hold for a monotonically decreasing value function.

(b) Now that the end points for the value function have been determined - the magnitude of the attribute measure that has a value of 0.5 must be established. This is the attribute measure level between the minimum and maximum level such that going from the x min to x.5 has the same value to the decision maker as going from x.5 to x max.

Let's return to the example of the infantry rifleman carrying magazines of ammunition. Assume that the minimum number of magazines of ammunition that the rifleman will carry is one magazine (no sane commander will order the rifleman into combat without ammunition - even if he is a proponent of 18th century bayonet attacks). However, the value that the rifleman attaches to the second magazine of ammunition is very high. The rifleman figures that having one magazine is just enough to get him sent into combat but not enough to bring him back alive. One magazine has zero value. Two magazines will be enough for most "normal" fire fights. The value to the rifleman of going from one magazine to two magazines is equal to the value of going from two magazines to five magazines. Using the notation above x.5= 2, x min= 1, and x max= 5 .

(c) By reasoning similar to that used in (b), the decision maker derives the attribute measure levels for x.25 and x.75 .

(d) Finally, a consistency check should be done to see if the value increase to the decision maker in going from x.25 to x.5 is equal to the value increase in going from x.5 to x.75 . If that is not true, then the additional questions must be addressed to arrive at the decision maker's true preferences for varying levels of the attribute measure.

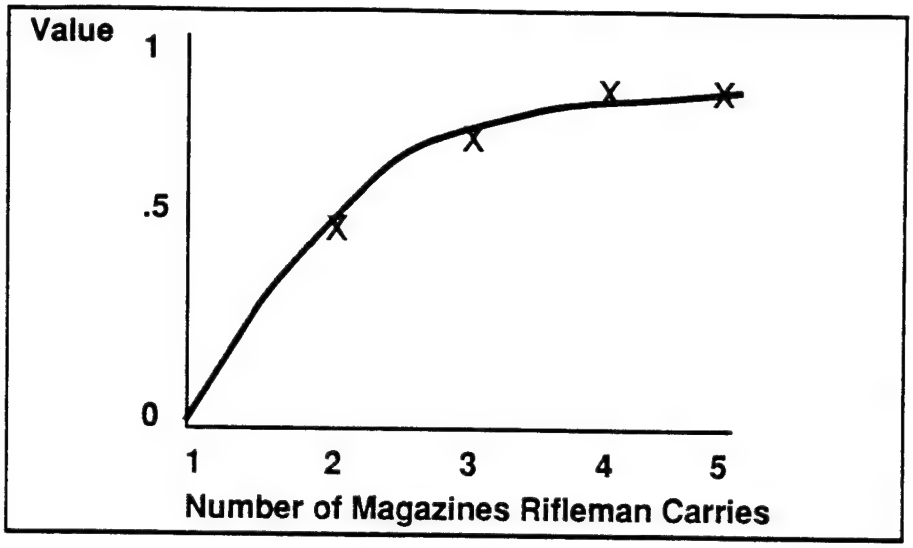


Figure D-2. Rifleman's Value Function (Ammunition)

The description of the technique to develop Single Measure Value Functions has a very subjective tone to it. The implication is that the decision maker almost arbitrarily assigns values to the different levels of the attribute measures. However, the decision maker usually has a strong reason for his preferences. That portion of the analysis was not discussed. In the simple example of the infantry rifleman, the rifleman had prior experience with fire fights and the ammunition resupply situation. If the rifleman did not know that he would be resupplied with ammunition before the next fire fight he would certainly have a higher preference for carrying more ammunition into combat.

For more complex situations, the decision maker will present more sophisticated sets of "evidence" to justify his (their) preference structures. Some examples of these sets of evidence are actual combat statistics, data from exercises, equipment test data, and output from computerized simulations of the combat environment. The more knowledge that the decision maker has the more accurately he can determine his preference structure.

The value function associated with each of the "lower level" attributes will be developed by using the concepts that were discussed in the preceding paragraphs. However, the ultimate objective of the MAUA technique is to take the Single Measure Value Functions (SVF) and combine them to produce a Multiple Measure Value Function (MVF) for the whole system. That is the subject of the next section.

1.4.2 Determination of the Multiple Measure Value Functions. The multiple measure value functions that represent the decision maker's preference for various combinations of the levels of the attribute measures can be expressed in the general form:

$$v(x1, x2, \ldots, xn) = f[\, v1(x1), v2(x2), \ldots, vn(xn) \,]$$

where xi is a specific amount (level) of the attribute measure Xi, f is a scalar-valued function, and vi is a value function over Xi. The symbol Xi represents both the attribute and the measure for the attribute.

The question is - what form does the function f take? Of particular concern are the conditions under which the multiple measure value function is an additive function of the single measure value functions that have been developed for each of the "lower level" attributes. In other words, what are the conditions that that allow

$$v(x1, x2, \ldots , xn) = \text{SUM OF } vi(xi) \text{ from } i=1 \text{ to } i=n$$

It turns out that the additive value function (described above) exists if and only if the attributes are mutually preferentially independent.

The attributes X1, X2, ... , Xn are mutually preferentially independent if every subset Y of these attributes is preferentially independent of the complement to that subset of attributes.

The set of attributes Y is preferentially independent of the complementary set Z if and only if the preference structure (i.e., the preferred ranking of the Y's) is not affected by the level of the Z attributes. An example, if the benefit vector y' is deemed better than the benefit vector y" at cost z' and for any other cost z" then Y is preferentially independent of Z. If the decision maker can show that the set of attributes Y is preferentially independent of the complementary set of attributes Z, then he can concentrate his efforts on structuring his preferences among y's holding z' fixed, knowing full well that this effort does not have to be repeated for different levels of z. In this case it is meaningful for the decision maker to structure a value function vy defined on y's without having to specify a particular z'.

Having additive value functions is very useful because the additive value function is about as simple as you will find. However, to test for mutual preferential independence, there are n(n-1)/2 pairs of attributes that must be preferentially independent of their respective compliments, and this says nothing of the triples of attributes, and the like. But fortunately, it has been shown that the number of requisite preferential independence conditions necessary to invoke additive value functions is n-1, where n is the number of attributes. Also, it has been shown that:

If every pair of attributes is preferentially independent of its complementary set, then the attributes are mutually preferentially independent.

When actually using the additive value function, rather than using the form

$$v(x1, x2, \ldots , xn) = \text{SUM OF } vi(xi) \text{ for } i=1 \text{ to } i=n$$

it may be more convenient to scale v and each of the single-attribute value functions from zero to one. Thus, we will have the additive value function of the form

v(x1, x2, ... ,xn) = SUM OF ai vi(xi) for i=1 to i=n

SUM OF ai = 1 for i=1 to i=n and ai > 0

Both of the additive value functions above are equivalent if they are given consistent scaling. The scaling constants can be determined by establishing indifferences between sets of attribute levels. In other words, finding out from the decision maker how much of one attribute the decision maker is willing to "give up" to gain a given amount of another attribute such that the decision maker is neutral or indifferent to the combinations of attribute levels that are being compared. For example:

If a car is being compared on the basis of horsepower and gas mileage (gas mileage, horsepower) -

Alternative 1: (35 mpg, 120 hp)
Alternative 2: (20 mpg, 200 hp)

The question would be if you get 35 mpg - how much horsepower would you require to establish equivalence to 20 mpg and 200 hp?

(35 mpg, ???) = (20 mpg, 200 hp)

With questions like these, the scaling constants (ai's) can be determined.

Once the SINGLE MEASURE VALUE FUNCTIONS for the lowest level attributes have been established and the form for the MULTIPLE MEASURE VALUE FUNCTION has been determined, then the scaling constants will be determined by establishing indifferences between sets of attribute measure levels. With a MULTIPLE MEASURE VALUE FUNCTION established, system alternatives can then be compared by examining the magnitude of the corresponding MULTIPLE MEASURE VALUE FUNCTION for each alternative.

This completes the description of the Assessment Methodology. The next two sections will discuss the implementation of the process for Cooperative Engagement and give a concrete illustration of the methodology for a simple case (the infantry rifleman's problem).

1.5 IMPLEMENTATION OF THE ASSESSMENT METHODOLOGY

The overall Assessment Methodology has been described in previous sections. The current section will discuss the specific steps that must be accomplished to implement that methodology. These steps have been alluded to in the previous sections and will be given more in depth discussion at this point.

1.5.1 Determine Attribute Measure Levels for Each of the Candidate Cooperative Engagement Architectures. In the discussion of the Single Measure Value Functions (SVF), it was explained that a value is attached via the value function to each level of each of the attribute measures. The problem now is to determine the specific measure level for each of the "lowest level" attributes for each CE architecture. The CE architectures have been referred to as the alternatives in the previous general discussions of the assessment methodology.

How does the analyst determine the measure levels for the "lowest level" attributes? Basically, they are determined from the descriptions of the physical architectures that are to be compared. These physical architecture descriptions decompose the performance requirements down to a measurable level. The physical architecture descriptions do not state how the performance levels will be achieved. The how is determined by the systems engineers. The physical architectures extend the functional architectural description of what the system must perform to include how much of the what. For example, the what might be to track air targets and the how much might be 100 simultaneously. If the physical architectures describe systems that presently exist, the attribute measure levels are determined from the performance of the existing hardware. For systems that are not yet in existence, the analyst must determine performance levels from quantities provided by the architects. The analyst does not determine the performance levels. The architects determine the performance levels. The analyst may have to derive the attribute measure levels from the information provided by the architects because the attribute measures that are used to describe the system for analysis purposes may not be in one-to-one correspondence with the measures that the architects provide. The analysts and the architects may have decomposed the system in a slightly different manner or to different levels of detail for different parts of the hierarchy. That is perfectly acceptable but it does require work and coordination between the analysts and the architects to assure that the measures provided by the architects are properly translated by the analysts and accurately represent the characteristics of the system.

1.5.2 Battle Force Missions and their Relationship to the Assessment Methodology. Naval Battle Forces must have the flexibility to perform many missions. The huge investment that must be made to acquire and support a battle force precludes designing the battle force for a narrow set of missions. For each mission, the battle force architects must weigh the probability that the required mission will actually need to be performed and the damage that will be done to United States vital interests if the battle force can not perform the mission well. All missions do not carry equal weight. A mission that must be performed often and will result in great damage to US vital interests if performed poorly will receive the most attention from the battle force architects. Whereas a mission that is not very likely to occur and will result in little damage to the US interests if not accomplished will receive little or no attention from the battle force architects. The difficult missions for the battle force architects to assess are the ones that are not likely to occur but will result in extensive damage to US interests if not performed well (e.g., strikes against the Soviet homeland). On

the other end of the spectrum are the so-called Contingency and Limited Objective Warfare (CALOW) situations which have a high likelihood of occurrence but result in little damage to US vital interests. These later situations are the "violent peace" scenarios that if left uncovered will have a cumulative effect that is equal to the most "stressing" scenarios. It is difficult to design battle force systems that are flexible enough to cover all of these situations well.

How does the wide spectrum of missions affect the assessment of the Cooperative Engagement Architectures? The relative importance of each of the attributes of the battle force will vary with the mission that the battle force is asked to accomplish. Therefore, the value functions for each of the attributes that describe the system should be changed for each of the possible missions. That is one way to handle the problem. The different Cooperative Engagement Architectures will be assessed on a mission by mission basis. If the relative "weight" (a function of the probability of occurrence and impact on vital US interests) of each mission can be determined then the value of the architecture can be assessed for each mission and the "overall" value can be determined to be the "weighted sum" (or other mathematical function) over all of the mission values. In any of these cases, the assessment results will be influenced by the missions that the battle force is required to perform and therefore the determination of the sets of missions is inextricably entwined with the assessment efforts.

1.6 A HYPOTHETICAL EXAMPLE TO ILLUSTRATE THE ASSESSMENT METHODOLOGY

For the hypothetical example to illustrate the Assessment Methodology let us consider again the Infantry Rifleman Problem. This time the rifleman must consider the quantities of water, dry socks, and ammunition to carry with him when he goes into combat. This example is simple enough and also hypothetical enough to illustrate the Assessment Methodology without getting "bogged down" in "real" numbers.

Suppose the rifleman must go into combat in the desert where the temperature gets up to 120 degrees in the middle of the day. The rifleman also knows that the "water buffalo" will come around about once every other day to allow him to fill up his canteens with water. He also wants to change his socks twice a day so that his feet will stay in shape to march. It takes one day for a pair of socks to dry out thoroughly. Now the rifleman has a rather difficult decision to make. He can only carry so much weight or he will become exhausted in the desert heat. Does he carry water to survive the heat or does he carry ammunition to survive combat? Obviously, he needs both, so how much of each does he carry? How does any of this affect the number of pairs of socks that he will take?

The present problem illustrates the situation where the attributes water and ammunition are mutually preferentially independent but not functionally independent. They are functionally dependent because the sum of the weights can't be greater than the maximum weight that the rifleman can carry. However, the rifleman's preference for more water is independent of how much

ammunition he is carrying. Also, his preference for more ammunition is independent of the amount of water he is carrying. It is assumed in this case that the rifleman is indifferent to the amount of weight that he is carrying if the total weight is below the maximum amount that he can carry. However, the preference for dry socks (assuming socks have negligible weight) is both functionally and mutually preferentially independent of the amount of ammunition or water that he is carrying.

Assume that one magazine of ammunition weighs the same as one canteen of water and that the rifleman normally needs a minimum of two canteens of water every other day. He can barely survive on one canteen of water every other day. The total weight that the rifleman can carry is 5 canteens of water. The rifleman's SVF for canteens of water is depicted below.

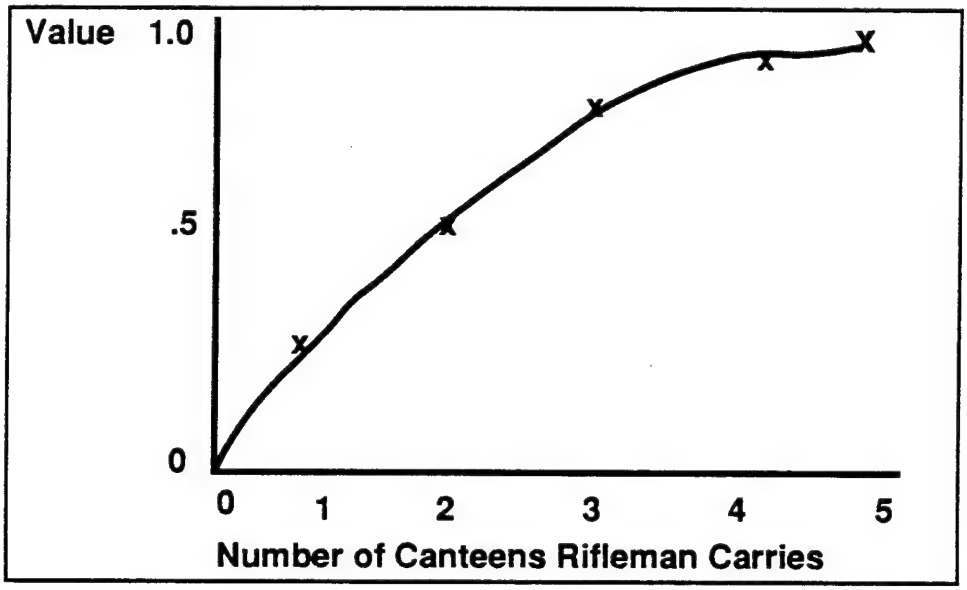


Figure D-3. Rifleman's Value Function (Water)

The rifleman's preference for dry socks is depicted on the next page.

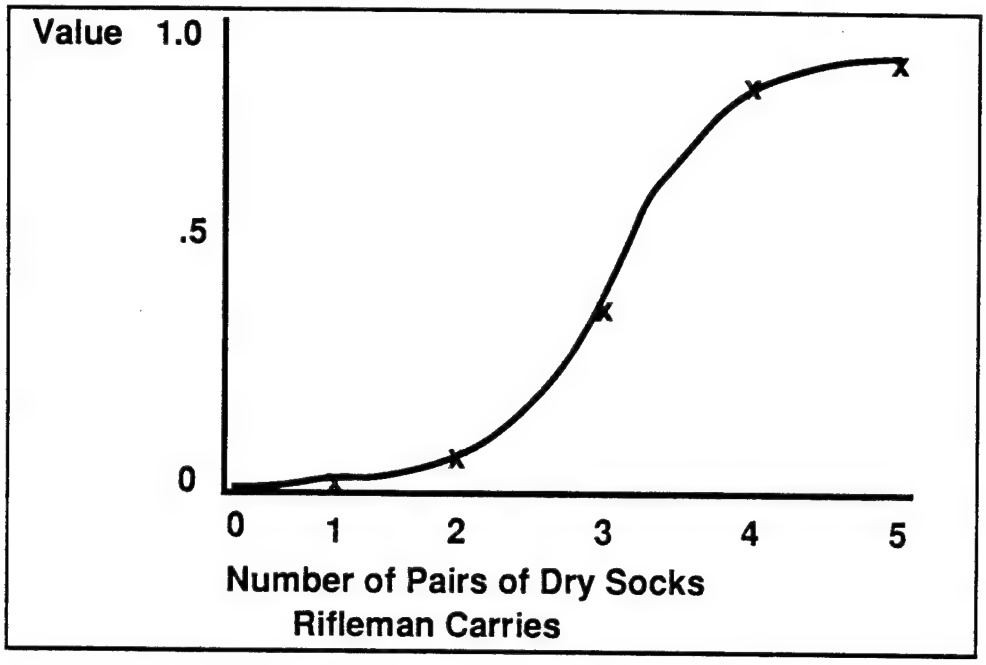


Figure D-4. Rifleman's Value Function (Socks)

Now, the SVF has been established for the individual attributes and the attributes are mutually preferentially independent. Therefore, the MVF has the form:

$$v(x1, x2, \ldots, xn) = \text{SUM OF } aivi(xi) \text{ for } i=1 \text{ to } i=n$$

The magnitude of the ai's must be determined subject to the constraints that:

$$\text{SUM OF } ai = 1 \text{ for } i=1 \text{ to } i=n,$$
$$\text{and} \quad ai > 0 \text{ for } i=1 \text{ to } i=n$$

Essentially, a series of indifference relationships will be used to establish the magnitudes for the ai's.

Solve for a2 in terms of a1.

$$(1, ?, 1) \; I \; (5, 1, 1)$$

How many canteens of water with 1 pair of socks and 1 magazine of ammunition is equivalent to (the decision maker is indifferent to) 5 magazines of ammunition, 1 canteen of water, and 1 pair of socks? The combination of 5 magazines of ammunition and 1 canteen of water violates the weight constraint and is used solely as a vehicle to establish the relationship between a1 and a2. The question mark will be answered with 3 canteens of water.

$$v(1, 3, 1) = v(5, 1, 1)$$

a2v2(3) = a1

From Figure D-3
v2(3) = .80

.8a2 = a1

Now find a2 in terms of a3

(1, ?, 1) I (1, 1, 5)

the question mark will be filled in with 2 canteens of water

a2v2(2) = a3
v2(2) = .5
.5a2 = a3

a1 + a2 + a3 = 1
.8a2 + a2 + .5a2 = 1

a2 = .435
a1 = (.80)(.435) = .348
a3 = (.5)(.435) = .218

So, the Multiple Measure Value Function is:

v(Ammo, Water, Socks) = .348v1(Ammo) + .435v2(Water) +
.218v3(Socks)

Now that the Multiple Measure Value Function has been determined, the next problem is to determine the alternatives that will be compared. How many combinations of (Ammo, Water, Socks) are there?

Ammo goes from 1 to 5 magazines
Water goes from 1 to 5 canteens
Socks goes from 1 to 5 pairs

Therefore there are 5x5x5 = 125 possible alternatives!! However, all combinations of Ammo + Water > 5 violate the weight constraint for the rifleman. Since the number of pairs of socks is functionally independent of the amount of water or ammunition carried, the rifleman will choose to carry 5 pairs (because it has the highest value). So, combinations with 5 pairs of socks dominate all other combinations with fewer pairs of socks. Considering the weight constraint, the rifleman is left with these combinations of (Ammo, Water, Socks):

(1, 1, 5) (1, 2, 5) (1, 3, 5) (1, 4, 5)
(2, 1, 5) (2, 2, 5) (2, 3, 5)
(3, 1, 5) (3, 2, 5)
(4, 1, 5)

(4, 1, 5) dominates (3, 1, 5), (2, 1, 5), and (1, 1, 5)
(3, 2, 5) dominates (2, 2, 5) and (1, 2, 5)
(2, 3, 5) dominates (1, 3, 5)

The number of alternatives is reduced to four:
(Ammo, Water, Socks)
(4, 1, 5)
(3, 2, 5)
(2, 3, 5)
(1, 4, 5)

Now, calculate the value function magnitude for the four alternatives. Use Figures D-2, D-3, and D-4 to determine values for the different measure levels.

ALTERNATIVE 1:
4 magazines of ammunition
1 canteen of water
5 pairs of socks
v(4, 1, 5) = (.348)(.85) + (.435)(.25) + (.218)(1)
v(4, 1, 5) = .63

ALTERNATIVE 2:
3 magazines of ammunition
2 canteens of water
5 pairs of socks
v(3, 2, 5) = (.348)(.7) + (.435)(.5) + (.218)(1)
v(3, 2, 5) = .68

ALTERNATIVE 3:
2 magazines of ammunition
3 canteens of water
5 pairs of socks
v(2, 3, 5) = (.348)(.5) + (.435)(.85) + (.218)(1)
v(2, 3, 5) = .76

ALTERNATIVE 4:
1 magazine of ammunition
4 canteens of water
5 pairs of socks
v(1, 4, 5) = (.348)(0) + (.435)(.9) + (.218)(1)
v(1, 4, 5) = .61

Rifleman's Conclusion: Based on the above analysis, the rifleman would choose to carry 2 magazines of ammunition, 3 canteens of water, and 5 pairs of socks into combat. Because the number of pairs of socks is functionally independent of the other attributes, the number of pairs of socks is essentially unconstrained and therefore the maximum number is chosen.

Even for small problems the number of calculations becomes voluminous. Fortunately, several microcomputer based software packages are available to automate the procedure illustrated by the hypothetical example problem "solved" in this section.

2.0 References

R. L. Keeney and H. Raiffa, Decisions with Multiple Objectives: Preferences and Value Tradeoffs, John Wiley and Sons, 1976.

S. French, Decision Theory, Ellis Horwood Series in Mathematics and Its Applications, 1988.

D. Bunn, Applied Decision Analysis, McGraw-Hill, Inc., 1984

E. S. Quade and W. I. Boucher, Systems Analysis and Policy Planning, Elsevier North Holland, 1968.

Logical Decision Multi-Measure Software, Logical Decision, 1989.

APPENDIX E

COOPERATIVE ENGAGEMENT DEMONSTRATIONS

By
Dr. David Townsend
U.S. Naval Research Laboratory

Table of Contents

THIS PAGE INTENTIONALLY LEFT BLANK

PURPOSE OF DEMONSTRATIONS

A Cooperative Engagement Demonstration should be an integral element of a broader demonstration of a new warfighting capability against a significant Navy threat in which cooperative engagement is essential. The sea-skimming anti-ship cruise missile (ASCM) is such a threat. It has been a concern to the Navy for over 20 years, and defensive capabilities are very limited without cooperative engagement. The elements of the system design for sea-skimmer defense must conform to the cooperative engagement architecture and satisfy the requirements imposed by the threat. The demonstration, therefore, should test both the essential elements of the cooperative engagement architecture and the technologies and design concepts necessary to achieve the required AAW capability.

A system configured to perform a feasibility demonstration probability will not have the full capability of either the cooperative engagement architecture or of the low observable sea skimmer defense system. For instance, the data links in the demonstration may not be highly jam resistant or the radars may not be able to detect the smallest cross section targets at the greatest range, but the results of the demonstration should be scaleable to more stressing situations. In view of this, any such demonstration should be designed with consideration of the ultimate objective of both the goal architecture and the purpose for which that architecture was designed. The details of such a demonstration depend on a careful consideration of the technical objectives, operational constraints, cost, and schedule. They are also likely to change when these issues are addressed in depth. Furthermore, the demonstration should build on and be consistent with other projects in progress.

The details of the necessary technologies cannot be determined without establishing requirements. For instance, the magnitude of the jamming threat and the mission performance functions will determine the AJ performance required, or the size of the cooperative engagement force will determine the opportunities for and the complexities for controlling cooperative detect, control, and engage functions. In any demonstration there will be a number of presuppositions, and the ultimate nature of the demonstration will be determined by the tradeoff between the comprehensiveness and fidelity of the demonstration and cost/schedule constraints. But, a properly planned operational demonstration will allow the Navy to build a cooperative engagement system that can be expanded to include future capabilities.

Most of the technologies mentioned in the basic document support, but are not essential to, AAW cooperative engagement capabilities. These technologies can be developed somewhat independently of a cooperative engagement capability (e.g., improved radars with greater clutter rejection for VLO targets). However, there are a few unique capabilities and their associated technologies that are essential to the successful development of a cooperative engagement system. Four essential capabilities for cooperative engagement follow:

(1) Platforms must be able to pass a fire control quality picture between cooperating units to achieve third party targeting or forward pass capabilities.

- Demonstrate the feasibility of high capacity, directional two-way data links
- Demonstrate spatial acquisition between high gain, low side lobe antennas
- Demonstrate the initiation and maintenance of communication during maneuvers
- Demonstrate the initiation and maintenance of communication while jammed
- Demonstrate low probability of intercept communications
- Demonstrate real-time RF power control to aid LPI and signature management
- Demonstrate the formation of subnets in clear and jammed environments
- Demonstrate net entry synchronization and reacquisition
- Demonstrate cryptographic protection of high capacity data links
- Demonstrate the capacity to support multiple missiles/target engagements
- Demonstrate the accuracy and sufficiency of fire control data
- Demonstrate relaying data to support OTH capabilities

(2) A launch platform must be able to handoff weapon control to another platform to achieve a forward pass capability.

- Demonstrate a simulated forward pass capability

(3) Positions of cooperating platforms, threats, and weapons must be known with accuracies, timeliness, and update rates sufficient to support a weapon.

- Demonstrate the position accuracy obtainable
- Demonstrate timeliness in measuring, processing, and distributing position data
- Demonstrate the rate at which position data can be updated

(4) Some means for assessing, managing, coordinating, and controlling platforms participating in a cooperative engagement must be provided to ensure that engagements are successfully and efficiently carried out.

- Demonstrate threat evaluation, target/weapon pairing, and platform selection for a cooperative engagement (i.e., based on the threat and weapons available select the best targeting platform(s), launch platforms, and guidance handoff platforms)
- Demonstrate coordination and control tasking for third party targeting
- Demonstrate coordination and control tasking for a forward pass capability

Much needs to be determined about the characteristics and capabilities of cooperative engagement systems. A program aimed at defining requirements for a cooperative engagement system should include a program for concept definition, analysis, and demonstration. As mentioned earlier, technologies for AAW cooperative engagement are stressed here but are not meant to exclude other warfare areas. An AAW cooperative engagement system must support third-party targeting and forward-pass to maximize placement of weapons on target while minimizing weapons expenditure per kill.

An airborne AAW cooperative engagement system comprises platforms, sensors, weapons, information processing means, and information transfer mechanisms. The ultimate effectiveness of the engagement system relies upon the mutual support each interacting element can provide to the total warfighting capability. Physical and economic limits bound the performance expectation of each element and, in order to achieve the desired level of warfighting effectiveness in the expected threat environment, it will be necessary to provide a balanced architectural and system engineering context that maximizes the contribution each element can provide. Although new weapons and platform capabilities have been proposed and, in some cases, development programs have been planned or started, there is insufficient understanding of the interactions between the elements contributing to airborne AAW engagement to

provide adequate assurance that each element has been optimized. In particular, the contributions of adequate information transfer between cooperating platforms and to weapons in flight have not been quantified adequately and the effect that such capabilities may have on either enhancing or minimizing requirements relating to sensor, platform, and weapons capability has not been considered comprehensively.

The requirements for information transfer and the quantification of its contribution to warfare missions cannot be assessed independently from postulations of missile, sensor, and platform characteristics and assessments of the threat environment. Consequently, two initiatives are considered. The first is primarily analytical and would develop proper weapon, platform, sensor, information processing, and information transfer contexts or options from which information transfer or netting requirements can be inferred. Specific analyses needed to provide this context and to provide the information affecting requirements for missile, sensor, processing and platform elements. These are listed in the next section.

The second initiative is to show the feasibility of an advanced netting approach that can support airborne AAW cooperative engagement. The demonstration portion of this initiative focuses on the exchange of fire control data for third-party targeting and forward-pass. Assets able to track targets would use the netting system to pass fire control quality targeting data to assets not tracking the targets. The ultimate objective of the conceptual AAW cooperative engagement system includes a capability to exchange surveillance data, target sorting data, and attack coordination messages among all platforms. Specific issues to be resolved in the demonstration are:

- Achievable accuracy and efficiency of fire control data transfer among multiple platforms
- Feasibility of fire control data relay, conceptually supportive of OTH operation
- Ability to support third party simulated missile launch
- Ability to support of simulated forward-pass
- Net entry synchronization and reacquisition performance
- Capability for network initiation in jamming environment
- Capability for initiation and maintenance of communication during platform maneuvers
- Capability to form and reform subnets in the clear and when jammed

- Ability to operate with low probability of intercept
- Determination of position accuracy obtainable
- Ability to support multi-missile, multi- target engagements

The demonstration objectives also include getting data to support analyses and extrapolations of system performance that can be used to determine requirements for a later AAW cooperative engagement system development program. An assessment of existing and planned technologies has been included to ensure that an AAW cooperative engagement system has the advantage of a comprehensive investigation of available technology and that there is adequate coordination so that unnecessary redundancy can be eliminated.

DEMONSTRATIONS

Definitions for CE Demonstration

The long term technology objective is to support the development of an architecture for a cooperative engagement capability among U.S. Navy combat systems. From the AAW perspective, the feasibility of the various aspects of airborne combat system netting and cooperative engagement needs to be assessed, the utility of these capabilities needs to be evaluated, subsystem performance requirements and tradeoffs for a cooperative engagement capability need to be identified. Issues related to the netting of airborne combat systems with surface combat systems must also be addressed.

- Force architectural analyses – The Force Architectural Analysis effort would study the affect of alternative cooperative engagement capabilities on AAW effectiveness. In particular, it would examine the Force architecture structure(s) made possible by or required in support of the cooperative engagement alternatives. The effort would include identification of force structural alternatives, force architectural structure analysis, identification of force interface options, definition of force interfaces, and definition of force information transfer elements.

- Airborne Engagement Information Management Analysis – The first objective of this task would be to identify the issues in the areas of networking, sensor tracking performance, and track correlation capability likely to have a significant effect on the feasibility and performance of airborne combat system netting. These issues would be investigated to develop a quantitative understanding of the relationships among the networking approach, sensor performance parameters, approaches to track file creation and updating, the ability to accomplish multi-source correlation, and data processing needs.

Three subsidiary subtasks include the determination of data accuracy/update requirements, the determination of battle database requirements, and the determination of processing requirements. Each is described below.

Subtask 1 – Determination of Data Accuracy/Update Requirements. The purpose of this subtask is to develop insight into the potential benefits of airborne combat system netting and cooperative engagement, and to determine the types of operational situations which drive system performance requirements. The effects of target signature characteristics and sensor disposition on the ability of airborne combat system netting to enhance battle force surveillance capabilities would be investigated. Data accuracy and update options would be analyzed parametrically for surveillance, weapons, and environment alternatives. Warfare effectiveness and the constraints imposed by the dynamic air-to-air environment would be assessed.

Subtask 2 – Determination of Battle Database Requirements. This subtask is to identify elements required to be in a battle database to support cooperative engagements. Requirements for database information accuracy, timeliness, update rate, and resolution would be postulated and the relative importance of each class of information would be assessed.

Subtask 3 – Determination of Processing Requirements. Under this subtask, the required characteristics of sensor information and the performance capabilities of the data fusion processing aboard the airborne platforms participating in combat system netting and cooperative engagement would be analyzed. The tradeoffs involved in using centralized versus distributed multi-platform/multi-sensor data fusion would be identified. The factors which drive the sophistication of the filtering and association algorithms used, and the effects of the various types and accuracies of weapons and sensor data available would be investigated.

- Sensor Data Analyses – This task addresses the feasibility and utility of the netting of airborne sensors in an AAW environment. Factors such as the disposition of sensor platforms and enemy platforms, sensor performance, target signature characteristics, and countermeasures employment would be analyzed to determine their influence on surveillance capabilities and system performance requirements.

For a specific scenario, the capability of the airborne surveillance radars to observe various target types as they penetrate to their weapon release points would be determined. Initial detection ranges, the fraction of time the target is observed by 0, 1, 2, etc. sensors, and the duration of the detection opportunities would be calculated.

A technique for determining the ability of a field of IRST sensors to detect a target moving through the field would be developed. The detection opportunity statistics for several representative target and sensor types would be evaluated and compared to the radar results that have been obtained.

- Weapons Employment Requirements – This task is intended to evaluate the capabilities of airborne weapons systems to perform cooperative engagements, to determine the conditions under which such engagements are likely to happen, and to identify constraints on engagements involving multiple friendly platforms. It is expected that these results would show the utility of a cooperative engagement capability and provide data (such as the limits on engagement geometry) which would be needed in prosecuting other tasks.

  The kinematic capabilities of current and technically feasible platforms and weapon systems to perform cooperative engagement of various targets would be evaluated. The maximum launch ranges and acceptable targeting platform positions that can support such launches and engagements would be computed. The analyses would consider the AIM-54C, AMRAAM, AAAM, SM-2 Block 3, SM-2 Block 4, and other technically feasible weapons, as needed.

  The effects of target tracking errors, track update rates, platform relative navigation errors, etc. on the ability of AAW systems to conduct cooperative engagements of hostile targets would be evaluated.

  Various sources of error in the targeting data and guidance commands for several representative cooperative engagement situations would be identified and analyzed. This effort would include determination of the dominant error sources and would compare the overall errors to the missile acquisition capability. It would assess whether cooperative engagements are feasible (and if so, for what conditions) for existing weapons and fire control systems, and for reasonable improvements to these systems.

- Data Exchange Analysis – This task is intended to define the data exchange requirements for an airborne cooperative engagement system and for its constructive interaction with a surface cooperative engagement system. The task is divided into two subtasks.

Subtask 1 – Netting Attribute Requirements. A preliminary estimate of the types of information that must be exchanged to conduct cooperative engagements, and estimate of the required channel access delays and data update rates would be developed. The communications capacity that should be reserved to support various numbers of simultaneous cooperative engagements would be computed. The required net functionality, net control mechanisms, reconfiguration requirements, net sizes, number of subnets, security needs, late entry capability, error performance, and robustness would be determined.

Subtask 2 – Communication System Options. This subtask would define communication system options including frequency choice and operating mode. It would quantify AJ and LPI performance needs and would estimate performance potential in appropriate threat environments based on the choice of frequency and mode of operation, and on postulated enemy scenarios. . It would provide an evaluation of communication alternatives considering platform penalties and constraints, interoperability potential, and complexity in interfacing with surface cooperative engagement systems.

Concept Demonstration

The objectives of this element are to determine the feasibility of an integrated AAW cooperative engagement system, to demonstrate in particular those aspects that provide an integrated fire control data distribution capability, and to develop information that can be used to support realistic specification of such a system for future development efforts.

- Task 1 – Fire Control Information Network Concept Definition. An approach to a fire control information network would be defined and related to a cooperative engagement concept as it would perform in an AAW scenario such as air-ship forward-pass defense against a fast, sea-skimming anti-ship missile. The concept definition would include identification of the following elements:
  (a) Platform participants
  (b) Missile characteristics
  (c) Communication mechanism (frequency, power, modulation mode, capacity, AJ features, LPI features, EMC assessment, etc.)
  (d) Networking concept including network control and organization
  (e) Source of position information
  (f) Missile guidance update mechanism
  (g) Fire control information requirements including missile initiation and command update error budgets

(h) Required accuracy and timeliness for fire control information transfer
(i) Required information transfer capacity
(j) Message types and structures/contents

- Task 2 – Performance Prediction. The performance anticipated from the selected fire control information networking approach would be predicted for a typical AAW scenario including the effects of sensor and communication jamming. The performance prediction would include:
  (a) Range supported in clear and ECM environments
  (b) Information transfer capacity supported in clear and ECM environments
  (c) Number of platforms and missiles supported simultaneously by cooperative engagement network
  (d) Performance of missile guidance and control concepts using two-way and one-way missile control links as supported by the cooperative engagement net.
  (e) Timeliness and accuracy of fire control information delivery, including position information
  (f) Influence of networking and fire control information transfer on likelihood of missile success

- Task 3 – Demonstration Design. Demonstrations would be defined for acquiring performance data and assessing the performance potential of fire control data network in an airborne cooperative engagement context. The demonstrations would include laboratory and ground experiments but would culminate in an airborne demonstration of the ability to carry out a cooperative engagement for the demonstration scenario (e.g., to engage a sea-skimmer beyond a ship's horizon using forward-pass to an aircraft). The demonstration design would include:
  (a) Identification of the demonstration/experiment that would be used to satisfy each of the demonstration objectives, including explicit description of which objectives would be satisfied by field test, by a combination of airborne and ground-based hardware, or by laboratory experiments and simulations.
  (b) Identification of the hardware and software that would be used to support a demonstration
  (c) Identification of the platforms and facilities necessary to support the demonstration
  (d) Establishment of a demonstration schedule including definition of the required availability of platforms and facilities
  (e) Identification of data to be measured for each demonstration/experiment phase
  (f) Identification of instrumentation approach and requirements to support each demonstration

- Task 4– AAW Cooperative Engagement demonstration and data gathering. The following would be demonstrated, as a minimum:
  - (a) Fire control data transfer among multiple platforms
  - (b) Fire control data relay, conceptually supportive of OTH operation
  - (c) Third party simulated missile launch
  - (d) Simulated forward-pass
  - (e) Net entry synchronization and reacquisition
  - (f) Network initiation in jamming environment
  - (g) Initiation and maintenance of communication during platform maneuvers
  - (h) Formation and reformation of subnets in the clear and when jammed
  - (i) Low probability of intercept operation
  - (j) Accuracy of position determination
  - (k) Support of multi-missile, multi- target engagements

- Task 5 – Data analysis and system performance extrapolation. Analyses and performance measurements relating demonstration system capabilities and performance measurements to conceptual system capabilities would be performed including those influenced by choice of demonstration system components, such as antennas or other items. These analyses are needed to quantify demonstration system/conceptual system relationships and to develop a means for extrapolation of demonstration results for:
  - (a) Missile initiation and command update error budgets
  - (b) Performance in jamming environment
  - (c) LPI performance
  - (d) Support for OTH operation
  - (e) Net acquisition and tracking, including spatial acquisition and beam pointing, if required
  - (f) Number of communication channels and net participants
  - (g) Number of simultaneous self-launched and remotely launched missiles that can be controlled and be supplied guidance updates (including identification and target assignment)
  - (h) Support for establishment and dissemination of tactical picture including data about self-launched and remotely launched missiles within platform sensor(s) and communication ranges
  - (i) Track capacity
  - (j) Percentage of transmitter resource used for communication and control
  - (k) Data transfer rate supported and potential allocation among surveillance exchange, fire control exchange, and battle management/coordination functions

- Task 6 – Final report and development recommendations. Navy Laboratories would prepare a report summarizing the results obtained

from each of the above tasks. The report would contain conclusions with respect to demonstration of AAW cooperative engagement system technical viability and recommendations for follow-on program(s), as appropriate.

ASSESSMENT OF CE DEMONSTRATION

The technology assessment task would investigate Navy and other service technology developments to ensure the benefit of other government investments and that technology trends applicable to an AAW cooperative engagement system and may be evaluated for use in this demonstration program or in successor development efforts.